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CONTENTS.

	PAGE.
Crop Pests and Diseases II	121
The Cassava Industry in British Honduras	123
Notes on the Contamination of Milk by Bacteria in the Tropics	124
Miscellaneous Notes	129
Banana Storage Investigations, 1937-39 ...	130
Mosaic Disease of Cassava	142
Some Remarks on Chile Saltpetre in relation to the Boron Question	143
Review	143
Comparative Investigations on the Composition of the Fat of the Germs, Shells, and Cotyledons of Cacao Beans	144
Caoutchoucine Denaturant	144
International Congress of Tropical and Sub-tropical Agriculture	145
Proteins of Black Bean	145
Sugar Notes	146
Chemical Notes	147
Trend of the Markets	148

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CROP PESTS AND DISEASES II.*

Methods of Control.

WE drew attention in our last issue to some of the general principles which underlie the working out of methods for controlling crop pests and diseases, stressing in particular the natural factors which limit their incidence. It remains now to examine the methods of control at our disposal. These may roughly be classified into two main groups: those which are aimed directly at destruction of the pest or disease organisms; these are usually chemical or mechanical measures, though biological control methods also come under this heading, and those which are aimed at assisting the crop to escape from attacks or at any rate to avoid the more serious form of injury. The production of resistant varieties and certain cultural measures come under the second group.

It is not proposed to discuss direct methods of control by the use of insecticides and fungicides, for the subject cannot be usefully treated in very brief fashion. Insecticides and fungicides such as sprays, dusts, poison baits and fumigants, are nevertheless our chief weapons at present in the fight against crop pests and diseases. In a sense they are palliatives and the time may come when only immune varieties of cultivated plants will be grown or when cultural methods are so well understood and applied that the natural resisting power of the crops will be such that pests and diseases affect them little. At the moment, however, this state of affairs seems a very long way off and we must continue to look to chemical methods as our chief means of control, at any rate so far as horticultural crops are concerned, and it is indeed in this direction that most progress has been made.

We come therefore to control measures that may be conveniently grouped under the term *cultural*. Most of the ordinary processes of crop husbandry, in so far as they aim at the production of healthy, vigorous plants, may be said to have an effect on the extent to which the resulting crops suffer from infestation by pests and diseases since, other things being equal, healthy crops may be expected on the whole to be more resistant than those in poor condition, or at least better able to withstand attack. Sir Albert Howard has recently stressed this point of view in several cogent addresses and papers. He holds that

* Adapted from an article by C. T. Gimingham, O.B.E., B.SC., F.I.C., in *Science Progress*, Vol. XXXIII, No. 132, 1939.

insects and fungi attack *only* unsuitable varieties or poorly grown crops and that all our efforts should be directed towards providing conditions for perfectly healthy growth, for example, by seeing to it that the supply of humus in the soil is well maintained. On this view, it is a mistake to use insecticides or fungicides since the pests or diseases are useful in indicating crops poorly grown or unsuited to the particular soil or climate—and such crops should either be better grown or their cultivation abandoned. Although probably few biologists find it possible to go the whole way with Sir Albert Howard, it is most valuable to have had attention drawn so strongly to the important influence of the factor of plant health on infestation by pests and diseases. That many other factors (some of which have been referred to) are also concerned seems certain, and the difficulty is to disentangle the effect of the healthy factor from the others. Instances of severe attacks upon apparently healthy and vigorous crops can be cited, and we cannot afford to abandon measures aimed more directly at control or protection.

The importance of *cultural control measures* in this connection is apt to be underestimated. It is true that they are rarely completely effective, but in a great many instances their judicious use at the appropriate time may greatly reduce losses from pests or diseases and they are usually cheap as compared with the use of insecticides or fungicides. Measures such as the application of fertilisers or thorough cultivation, ploughing, or rolling, may at times so help the crop that it is enabled to grow away from attack. Such methods may, for example, be helpful in reducing the harmful effects of certain insects which live in the soil, and since chemical methods, such as the application of soil insecticides, are seldom economically practicable at present, suitable cultivation has to be relied on to a great extent in our efforts to keep such insects in check.

An interesting example of the possibilities of cultivation as a control measure is the outcome of quite recent work at Rothamsted Experimental Station on the "Take-all" or "Whiteheads" disease of wheat due to the fungus *Ophiobolus graminis*. The fungus persists on the infected stubble and only slowly disappears through natural decomposition. It appears that the rate of its disappearance is closely associated with the numbers and activity of the micro-organisms in different soils, and it has been found that their activity may be increased and the destruction of the fungus hastened by incorporation of additional organic material with the stubble and by subsequent cultivations of the soil. Further field work on the subject is in hand, and it is possible that similar methods may be applicable in connection with other fungi in infected plant residues.

Clean culture and destruction of weeds are also important in relation to pest and disease control, for weeds often serve as host plants on which populations may be built up ready to infect the crop when it reaches the appropriate stage.

Alteration of the time of sowing or planting such as is adopted in the Leeward and Windward Islands to reduce attacks from the pink boll worm and cotton stainers, or the use of varieties naturally earlier or later than the normal, are means which enable crops to escape attack.

Finally, under the heading *cultural means* is the important subject of *crop rotation*. Where the same crop is grown for a number of years in succession on the same land, or on closely adjoining areas, the chances of infestation by pests and diseases are at a maximum, and one of the advantages of the ordinary practice of rotation of crops is to diminish this risk. Obviously no hard-and-fast rules can be laid down, since so many considerations other than pest control must be taken into account; but as a general principle, wherever conditions allow, a crop should be grown as far removed as possible, both in time and space, from fields carrying the same crop or other crops susceptible to the same pests and diseases. This is perhaps a counsel of perfection, but the matter undoubtedly deserves more attention than it often receives and avoidable losses are not infrequently incurred by failure to bear it in mind. It is probable that the apparent spread of the "take-all" disease referred to above, is connected with changes in methods of farming in which the interval between cereal crops is shorter than in the older rotations. It is, no doubt, present-day economic conditions that lead to neglect of the old principle of rotation, but such neglect will almost inevitably involve certain penalties.

Closely related to the question of rotations is the bearing on the relative severity of infestation of the increasing tendency to specialise in particular crops in certain districts. By growing the same plant over wide areas, inevitably conditions are made even more favourable for the insect and fungus enemies of that plant than where general mixed farming is the rule. It may be that under modern conditions this tendency towards concentration of crops of the same kind in particular areas is inevitable, and it is well that we should face the fact that, with increasing specialisation, there is likely to be an increased incidence of pests and diseases and that the correct application of suitable control measures will become more, not less, necessary. Continually more favourable conditions for rapid multiplication of pests are being provided in the larger and larger "single crop" areas.

The control of crop pests and diseases by means of cultural methods has been dealt with at some length in view of the possibilities which they offer. It is not intended, however, to suggest that these methods are the only ones likely to be effective. On the contrary, there can be no doubt that protective measures such as spraying, dusting and similar methods must at present be regarded as our chief, if not, in many cases, our only weapons of defence, especially when it is remembered that agriculture involves the cultivation of plant species under highly artificial conditions of growth in which the natural balance of organisms is

disturbed. These conditions bring in their train numerous complex problems of fungous invasion and insect attack which can rarely be dealt with by soil amelioration. It is true, of course, that good soil conditions will always be at the base of sound agriculture but they alone are not sufficient to ensure resistance to all diseases and pests.

Though it seems certain that, for a very long time, work on the direct problems of control of pests and diseases must take precedence, yet it is of the utmost importance that the longer-range problems concerning the plants themselves and the environmental factors affecting their response to attack should receive more attention. Entomologists and mycologists concerned with the direct study of the insects and fungi attacking plants and of bacterial and virus diseases will be in a better position to make their contribution to the outstanding practical problems of control when they are in possession of fuller information about the part played by the plant itself.

THE CASSAVA INDUSTRY IN BRITISH HONDURAS.*

CASSAVA is commonly grown in British Honduras as a foodstuff, but the largest producers are the Caribs, who occupy lands in the Stann Creek and Toledo Districts. As well as a source of food the Caribs grow cassava for the manufacture, in a small way, of starch, all of which is consumed within the Colony.

During the last ten years or so a number of attempts have been made to organise the industry with the object of developing an export trade in starch and "gaplek" (dried peeled roots). Prior to 1930 samples of starch and meal were sent to the Imperial Institute for examination. These samples were prepared by the Caribs themselves. In 1930 the Department of Agriculture undertook a small experiment in the preparation of "gaplek" and shipped a trial shipment of 540 lb. to a firm in the United Kingdom. A small quantity of native-made starch was also sent. A most encouraging report was received, but no further shipments could be undertaken owing to the high cost of ocean transport and relatively low market value of the products.

In 1933 enquiries were received from an interested party in Canada regarding the possibilities of the manufacture of cassava starch in British Honduras. As the result of these enquiries an investigation on the spot was made by the persons concerned, and in 1934 the Empire Starch Products, Ltd., was incorporated. This company took up land in the Stann Creek Valley for its factory site as well as for the growing of cassava. While essentially a manufacturing company, the promoters early realised the need for an assured minimum production of raw material in case private enterprise should not readily fulfil the needs of the factory. For many reasons the start of operations was delayed until 1936. Rapid progress has been made since then, and by the end of 1937 the company had 400 acres cleared and planted under cassava.

The native planters have been slow to take advantage of this unique opportunity of being able to grow a crop they all understand and which up to now has been in a sense a drug on the market. This shyness can be attributed in part to the fact that they have not been used to dealing with manufacturers and therefore are suspicious of the treatment they may receive. Although they have been assured of a minimum price per ton for fresh roots of $6.00 (American) delivered at the factory or $5.50 at rail side, it will probably not be until the first few sales have been made and they see actual hard cash being paid that a general planting programme will be undertaken. There is an area of approximately 200 acres of native-grown cassava in the neighbourhood of the factory which will be available for manufacture by the time the factory is erected.

The factory was put up early in 1938 and includes all the latest improvements. Its capacity is estimated at approximately 2,500 tons of starch annually, but with certain alterations and additions this can be considerably increased.

The Department of Agriculture has for the last few years attempted to interest the native growers in this project. Whilst it may be thought that these attempts have not been very successful, the authorities are not discouraged as they feel that it is only a question of time before the crop is more generally grown and in larger quantities. Variety and cultural trials have been in progress on a semi-commercial scale and as a result it is now possible to supply some useful information on methods of cultivation and varieties worth growing. The most useful result, however, has been the ability of the Department to supply the greater bulk of cuttings the company required for its planting programme. Owing to the rapid rate at which the company had to plant its first fields and the fact that most of the area chosen was in high forest or old second growth forest most of the planting was done without ploughing. Judging from the growth made the rough method of preparing the land has had little retarding effect, and yields are expected to be satisfactory.

A small experimental factory was established on the Agricultural Station, Stann Creek, in 1935 in order to obtain first-hand information on costs of production and possible quality of manufactured starch. A grater and grinder were imported, the remainder of the equipment being made locally. Samples were submitted to potential buyers in Canada and the bulk of the output has been disposed of in that country. Reports received from the users state that the product is equal in all respects to that purchased from Java.

In order to encourage the industry Government has given certain concessions to Empire Starch Products, Ltd., to assist it in its initial stages. With the help of a grant from the Colonial Development Fund, Government is also constructing a road from rail-side through part of the company's plantations to the factory side, a distance of about two miles.

* *Bulletin of the Imperial Institute*, Vol. XXXVI, No. 1, pp. 66-68.

NOTES ON THE CONTAMINATION OF MILK BY BACTERIA IN THE TROPICS.

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Introduction.

The bacterial contamination of milk and the precautions which must be taken in the production of clean milk have been the subjects of many investigations.

Bacteria are minute organisms which are only visible under the microscope. Many of them will grow and multiply readily in milk. Most are harmless, but some cause human diseases ; for example, the bacilli of the *coli* group which occur very commonly in decomposing refuse, manure and dung and which, if introduced into the digestive tract in any way, cause various intestinal complaints. More serious diseases such as typhoid and dysentery may also be transmitted readily in milk which has become contaminated with the necessary bacteria, either from the milkers, or through the use of contaminated water for washing the dairy and utensils. The bacillus which causes tuberculosis may also be distributed in the milk of cows which are suffering from this disease, but the danger of infection from this source can be eliminated if the cows are tested at regular intervals, and those suffering from the disease removed. In Great Britain the Milk (Special Designations) Order of 1936 (7) lays down that the tuberculin test must be performed at six-monthly intervals at the outside if the milk from the herd is to be sold as ' tuberculin tested '.

In addition to their importance as carriers of certain diseases, bacteria are largely responsible for causing milk to turn sour. Barkworth, Meanwell and Taylor (2) quote figures that show that milk containing over 750,000 bacteria per cc. will turn sour in about two-thirds of the time taken by milk which contains less than 1,000.

Estimation of the Bacteria.

Various methods have been suggested for estimating the number of bacteria present in milk ; the one discussed in this paper is known as the " Plate count ".

The Plate count will give the number of living bacteria or groups of bacteria present in a cubic centimeter of milk, which will develop on a plate of nutrient agar sufficiently fast to produce a colony visible to the naked eye, in a definite time under standard conditions. This method of estimation is open to the obvious objection that it will give no account of slowly growing bacteria, nor of bacteria which will not develop in the conditions under which the experiment is carried out. Also, though each colony is counted on the assumption that it arose from a single bacterium, there is no evidence that in some instances a group of bacteria is not actually responsible for the formation of the visible colony. The errors of this method are considered in detail by Wilson (6) and it is found that the " Plate count " is generally lower than the " Total count " for a given sample of milk. The method however is in general use in spite of its errors, and for the purposes of these investigations it was considered that the " Plate count " would give a sufficiently accurate estimate of the general cleanliness of the milk, in view of the fact that experimental conditions were standardised and all the readings were carried out by the same workers. It is not claimed that the number of bacteria recorded in any instance will represent the actual number of bacteria present in the milk, but the designation " Bacteria per cc." will be used throughout the paper to refer to the number of bacteria as determined by the Plate count.

The reliability of the technique can be gauged from Table I.

Table I.

Bacteria present in fifteen different samples of milk taken from the same can.

Bacteria per cc.	Percentage variation from mean.
73,000	+33
50,000	− 7
50,000	− 7
49,000	− 9
55,000	+ 2
59,000	+ 9
46,000	−15
48,000	−11
50,000	− 7
57,000	+ 6
50,000	− 7
52,000	− 4
67,000	+24
53,000	− 2
56,000	+ 4
Mean 54,000	

From Table I it can be seen that the greatest variation from the mean in these readings is 33 per cent. These figures should be borne in mind when considering the following results, and they show that readings made by this method can be used safely in comparing the bacterial contents of different samples of milk.

The Production of Milk of a Low Bacterial Content.

It should be the aim of every milk producer to supply milk containing as few bacteria as possible. Attention has to be paid both to reducing the chances of bacterial contamination at all stages during the actual production of the milk, and also to storing the milk under conditions when the multiplication of the unavoidable bacterial contamination will be reduced to a minimum.

Before it is possible to reduce the chances of bacterial contamination of milk it is necessary to know the stages at which the contamination most commonly occurs. It seems to be only rarely that perfectly sterile milk can be produced. There does not appear to be any anatomical impediment to the free entrance of bacteria into the udder, and Ward (5) states that bacteria may be found in the lactiferous ducts throughout the udder. These bacteria will contaminate the milk as soon as it is secreted. In healthy udders this type of contamination is due to bacteria which have lodged on the outside of the udder and travelled up the ducts. It can be avoided to a certain extent by preventing the udders from coming into contact with highly contaminated material in foul pens or pastures, where large numbers of bacteria can lodge on the teats and migrate up the lactiferous ducts. Even with the strictest cleanliness however, contamination of the ducts will occur to a certain extent but will be confined largely to the lower parts, and the bacteria will be expelled with the milk from the teat in the first few pulls. For this reason the first milk should always be rejected.

Table II quoted from Ernst (3) shows a typical distribution of bacteria in milk as it is drawn from the cow.

Table II.

Bacteria per cc. at different stages of milking.

First milk.	*Middle milk.*	*Last milk.*
55,000-97,000	2,000-10,000	0-500

Milk from unhealthy udders of course will tend to be very highly contaminated at all stages and should never be used for human consumption.

After the rejection of the first milk the residual milk from a healthy udder should contain under 2,000 bacteria per cc. Any further contamination can be attributed to the air in the dairy, to the milker or to the utensils. The extent to which the air in the dairy is contaminated depends on the cleanness of the dairy itself, its surroundings and on the cleanness of the cows. The dairy should be washed thoroughly before each milking and a sufficient interval should be left between washing and milking to allow the dirt in the air to settle. There should be no bedding material on the floor while milking is in progress since this will harbour a large number of bacteria.

Table III illustrates the effect of presence or absence of bedding material in a well-run Trinidad dairy.

It is hardly necessary to remark on the great reduction in the bacterial content of the milk effected by the removal of the bedding material.

The cows should be thoroughly groomed before milking and especial attention should be paid to the cleaning of the udders and hind quarters.

Table III.

The effect of the presence or absence of bedding material during milking.

Churns sampled after milking with bedding material in stalls.		Churns sampled after milking without bedding material in stalls.	
Interval between Milking and Sampling (hours)	Bacteria per cc.	Interval between Milking and Sampling (hours)	Bacteria per cc.
5	50,000	17	27,000
5	75,000	17	30,000
5	100,000	17	30,000
21	125,000	17	35,000
5	130,000	18	40,000
17	140,000	—	50,000
5	150,000	0	50,000
—	190,000	0	60,000
5	200,000	17	100,000
5	400,000	17	120,000
17	900,000	—	—
	Mean 220,000		Mean 54,000

Their tails should be trimmed sufficiently to prevent their trailing in the dirt, though care must be taken not to impair their usefulness for removing flies. As an additional precaution the tail should be tied so that it cannot swing and scatter dirt and bacteria while milking is actually in progress.

The use of a pail with a small top reduces the area of milk which is exposed to contamination from the air and therefore reduces materially the number of bacteria found in the milk. Walton's (4) experiments (Table IV) illustrate this effect very clearly.

Table IV.

The effect of milking into a pail with a small top.

Cow No.	Open pail.	Small-topped pail.
1	5,000	4,000
2	12,000	2,500
3	9,000	2,000
4	10,000	3,000
5	10,000	3,000

The effect was even more striking when he compared the bacterial content of the mixed sample of the milk of six cows. With an open pail the mixed sample contained 100,000 bacteria per cc. as compared with 11,000 bacteria per cc. with a small-topped pail.

The health and cleanliness of the milkers is of the greatest importance in the production of clean milk, since the infection of many contagious diseases can be transferred to the milk from infected milkers. Clean milk cannot be produced

unless both the milkers and their clothes are scrupulously clean. The milker should always wear a cap and overalls which are used only for milking and these should be washed thoroughly at very frequent intervals. They must also wash their hands well before milking starts. The practice adopted by some dairies of providing a dilute solution of potassium permanganate in which the milkers wash their hands probably does much to help in the production of clean milk. The milkers must be careful not to touch anything which would contaminate their hands again after washing.

The practice of wet milking should never be allowed since the bacteria will accumulate in the milk which is kept on the hands and will contaminate all the milk produced.

The milking pails, cans and other utensils used in the dairy are a frequent source of contamination. Washing in clean water is not in itself sufficient to kill the bacteria adhering to the surface of the utensils, and they should all be sterilised in an efficient steam steriliser, and kept free from contamination until they are used. Ayers, Cook and Clemmer (1) found that on an average of 60 samples, milk collected in unsterilised pails contained 73,000 bacteria per cc. while milk collected in sterilised pails contained only 6,000. The maximum contamination of bacteria in the unsterilised pail was 280,000 per cc. while that in the sterilised pail was 21,000. During this experiment the unsterilised pails had been washed very carefully.

The effect of allowing the milk to stand at tropical temperatures is illustrated in Figure I.

Milk was collected in a sterile container and stored at room temperature (mean 80° to 84°F.) The bacteria were counted in samples taken hourly during the day. Samples A and B were both taken from the cooled milk of the morning milking and sample C was taken from the noon milking of the previous day, the milk having been held in cold store for 18 hours. The average room temperature when sample A was taken was 84°F. while when samples B and C were taken it was 80°F. This difference in temperature may account to a certain extent for the difference between the results of A and B. In all three cases there was a lag of about six hours after milking during which the number of bacteria did not increase appreciably. Ernst (3) quotes figures which suggest that there may be a reduction in the number of bacteria present during this period which they attribute to a germicidal property of fresh milk, but it may also be due to competition between different types of bacteria during the initial stages of this development. There is much evidence to suggest that this lag effect only occurs in samples of good

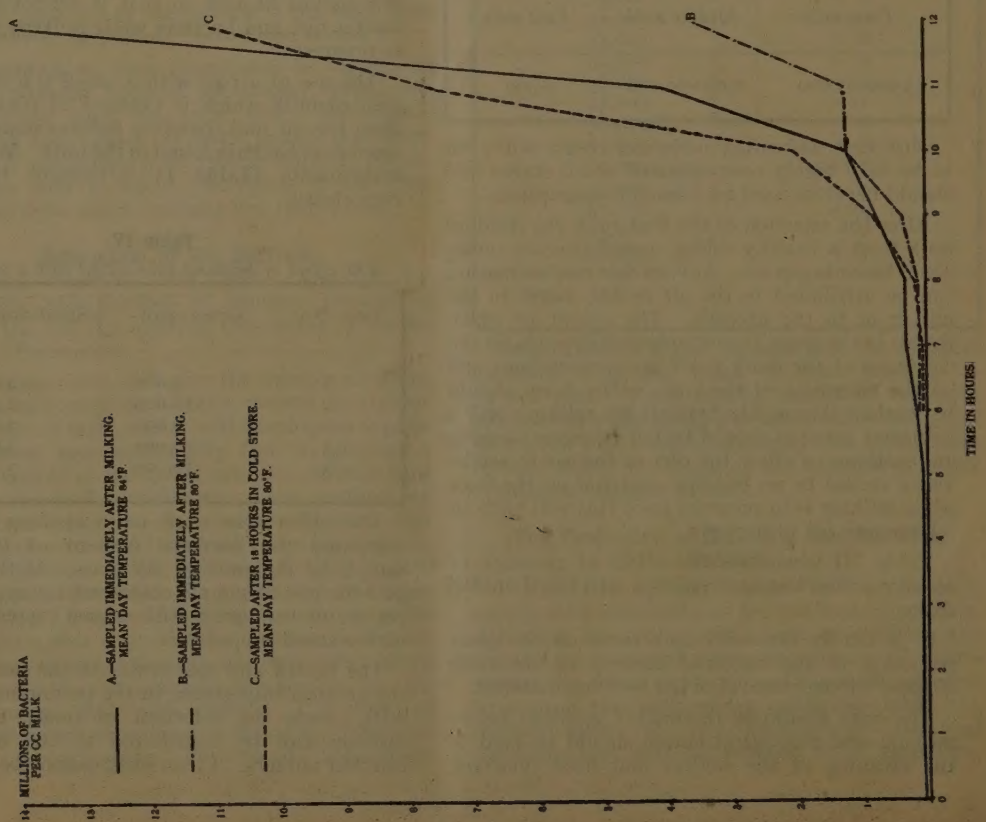
A
C
B
MILLIONS OF BACTERIA PER CC. MILK
A.—SAMPLED IMMEDIATELY AFTER MILKING. MEAN DAY TEMPERATURE 84°F.
B.—SAMPLED IMMEDIATELY AFTER MILKING. MEAN DAY TEMPERATURE 80°F.
C.—SAMPLED AFTER 18 HOURS IN COLD STORE. MEAN DAY TEMPERATURE 80°F.
TIME IN HOURS.

FIG. 1. THE MULTIPLICATION OF BACTERIA AT TROPICAL TEMPERATURES.

milk. The bacteria in milk produced under dirty conditions with a high initial bacterial content will start multiplying almost immediately under tropical conditions. Walton (4) also quotes figures in which the bacterial content of milk stored at 86°F. increased 7½ times its original value in only four hours, and in this case the milk was apparently of good quality at the start of the experiment. This initial lag in the multiplication of the bacteria is of considerable interest and requires further investigation.

These figures illustrate the importance of cooling the milk as soon as possible after milking. Even if the effect of standing at tropical temperature may not be apparent during the first six hours, the keeping quality of such milk will be seriously impaired, since after distribution the number of bacteria in the milk will start increasing very rapidly.

These factors in the production of clean milk have been summarised by Ayers, Cook and Clemmer (1) and in their opinion the four following rules must be followed if clean milk is to be produced :—

(*i*) The use of sterilised utensils.
(*ii*) The cleaning of the cows, particularly the udders and the teats.
(*iii*) The use of a pail with a small top.
(*iv*) The holding of the milk at a low temperature.

The effect of rigid adherence to these four rules on the quality of the milk produced is illustrated in Table V which shows the average occurrence of bacteria in the milk of six farms before and after the rules were enforced.

Table V.

Effect of enforcing four rules.

Farm No.	Average count before enforcing four rules Bacteria per cc.	Average count after enforcing four rules Bacteria per cc.
1	120,000	11,000
2	15,000	5,000
3	200,000	4,000
4	80,000	2,000
5	35,000	2,000
6	50,000	3,000

Table VI.

Sampled directly from milking pails and weighing pail.

Milking pail No.	Bacteria per cc.	
	Immediately after milking.	After weighing.
1	1,000	40,000
2	2,000	2,000
3	3,000	3,000
4	5,000	6,000
5	20,000	15,000

To this summary it might be as well to add that the general cleanness of the dairy is of very high importance.

Milk of a high standard of cleanness can undoubtedly be produced under tropical conditions if sufficient care is taken in ensuring general hygiene in the dairy. Table VI shows samples taken from five milking cans at one farm where no special precautions in addition to those already discussed had been taken.

Preparation of Milk for Distribution.

After milking, the milk is usually weighed and carried into the dairy where it is filtered and cooled, when normally it is either delivered directly to the consumer, in which case if efficient cooling and sterilising apparatus is used, milk of high quality should be produced fairly easily ; or the milk produced on one or more farms is sent to a central distributing station and processed before delivery. This of course takes longer, and a procedure typical for Trinidad is outlined below. The cooled and filtered milk is stored in 10-gallon cans in a cold room (temp. 42°F.) until it is carried to the central distributing station. The milk is transported once a day immediately after the morning milking.

Table VI shows that until immediately before cooling the milk has about the same bacterial content as when it is taken from the cows. The subsequent history of this milk is shown in Table VII. The cans were filled at the afternoon milking and held in the cold store overnight.

Table VII.

Can No.	Samples, bacteria per cc.		
	Cooler filling can.	Full can at Dairy.	Full can at distributing station.
5	25,000	30,000	35,000
18	23,000	30,000	30,000
44	25,000	20,000	Not sampled.

These figures show that there had been an appreciable increase in the number of bacteria in the milk during the filtering and the cooling, and there is some evidence to show that the contamination occurred mainly in the cooler. After cooling however the counts remained of the same order whether they were taken at the dairy or about twelve hours later at the distributing station, showing that the storage methods and the refrigeration temperature of about 42°F. were satisfactory.

The milk received at the central distributing station is pumped into a pasteuriser as quickly as possible and at this stage the milk received from different dairies is mixed, and it is a mixed sample of milk that is pasteurised. After pasteurising, the milk is cooled immediately, bottled and held in cold store until it is delivered, usually on the following morning.

Pasteurising consists in heating the milk to a temperature which is high enough to destroy many of the bacteria present but which will not give the milk a cooked taste or appearance.

The following specifications which govern the pasteurising process are quoted from the Milk (Special Designations) Order of 1936 (7).

"PART III.—(PASTEURISED).

1. The milk in relation to which the special designation is used shall be pasteurised, that is to say, retained at a temperature of not less than 145° and not more than 150° Fahrenheit for at least thirty minutes, and be immediately cooled to a temperature of not more than 55° Fahrenheit.

2. The milk shall not be so heated more than once and shall not be otherwise treated by heat.

3. An indicating thermometer and a recording thermometer shall be inserted in suitable places in the apparatus used for pasteurising during the whole of the pasteurising process. The type of apparatus and the thermometers used and the methods employed shall be such as are satisfactory to the licensing authority.

4. Temperature records shall be made and all such records shall be preserved for a period of not less than one month.

5. After the milk has left the receptacles in which the pasteurising process is carried out, it shall not be placed in any apparatus or storage vessels which are at any time used for milk which has not been pasteurised.

6. Every vessel in which the milk is transported or is exposed or offered for sale shall bear a suitable label with the words "Pasteurised Milk".

7. On a sample of the milk being taken after pasteurisation and before delivery to the consumer, the milk shall be found to contain not more than 100,000 bacteria per mililitre. The test shall be carried out in such manner as the Minister may direct."

The counts in Table VIII illustrate the extent to which bacteria were present in milk during the various stages of pasteurisation.

Table VIII.

Counts taken during various stages of pasteurisation.

Series No.	After clarifying before heating.	After heating before cooling.	After cooling before bottling.
1	85,000	under 5,000	10,000
2	88,000	do.	15,000
3	150,000	do.	18,000
4	250,000	do.	4,000

These figures show that under tropical conditions the normal pasteurisation process is extremely effective in reducing the number of bacteria present in the milk. But contamination occurs immediately after pasteurising and appears to be due to the cooling process. In the figures given contamination does not appear to be severe but it is sufficient to indicate a point of weakness. The contamination at this stage may be due to bacteria adhering to the surface of the cooler itself, which can only be removed by careful cleaning and sterilising or it may be due to the bacteria which will be collected by the thin film of milk flowing over the surface of the cooler and exposed to contamination from the air. In this case it may be avoided to a large extent by supplying the cooler with covers and placing it in a quiet part of the dairy. It must always be remembered that the cooler is a possible source of serious contamination and must be cleaned carefully.

It must be stated here definitely that pasteurisation will only improve the quality of milk which has been produced under hygienic conditions and has a low bacterial content. With milk of this type pasteurisation will effect an almost total removal of the bacilli of the *coli* group which have been mentioned above.

Milk with a high bacterial content must not be pasteurised. The heat is not able to kill all the harmful bacteria in the milk if these are present in large quantities, and the process may serve to enhance the development of the pathogenic bacteria by removing harmless bacteria which are competing with them.

It is evident from the data collected that provided the requisite precautions are taken, milk of a high degree of cleanliness can be produced on a large scale from a central distributing station in a tropical climate.

Bacterial Standards for Milk.

Since the extent to which milk becomes contaminated under tropical conditions and the stages where contamination is likely to occur have been considered it is possible to compare this contamination with the standards under which English milk is produced.

Wilson (6) recommends the following divisions for standardising milk :—

Grade A below 200,000 bacteria per cc.
Grade B 200,000-1,000,000 bacteria per cc.
Grade C over 1,000,000 bacteria per cc.

Under the Milk (Special Designations) Order of 1936 (7) the following standards are laid down :—

"Accredited" milk shall not contain more than 200,000 bacteria per cc.

"Pasteurised" milk shall not contain more than 100,000 bacteria per cc. when delivered.

"Tuberculin tested" milk shall not contain more than 200,000 bacteria per cc. and if it is pasteurised not more than 30,000 bacteria per cc.

There seems to be every reason to expect that milk produced in the tropics under hygienic conditions should be able to conform easily to these standards.

Summary.

1. The need of bacterial control of the milk supply in the interests of Public Health is outlined.

2. The estimation of the cleanliness of milk by the Plate count is discussed, and the accuracy of the technique is tested.

3. The conditions under which milk must be produced if the number of bacteria present is to be kept at a low level, are considered, and the stages at which bacterial contamination is likely to occur are pointed out.

4. The rules which govern the process of pasteurisation in Great Britain, and the effect of pasteurisation on the bacterial content of the milk are discussed.

5. The standards to which English milk must conform before it may be sold under a special designation are quoted.

Acknowledgments.

In conclusion the writer would like to express his thanks to Mr. R. E. D. Baker for his invaluable help and advice during the course of these investigations, and to Mr. Gerald Wight of Alstons & Co., who placed the Trinidad Dairies at the disposal of the writer during the course of the experiments.

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MISCELLANEOUS NOTES.

A Method of Weed Eradication.

Under the title, "Biological eradication of Kans (*Saccharum spontaneum*) in field patches" G. C. Tambe and Y. D. Wad of the Institute of Plant Industry, Indore, Central India, draw attention to what appears to be a simple and efficient method of eradicating troublesome weeds (*Agric. and Livestock in India*, 8, Pt. IV). The method adopted was to cover, by means of a thick mulch of green material such as sunn hemp, green grass or even green weed growth removed from fields, the patches of land overgrown with the particular weed desired to be destroyed, and allow the mulch to remain through the rainy season. At the end of this period it is found that the decomposing green material had acted on the root system of the weeds under the rotting cover green mantle and had effectively killed it. In addition to such destruction, the treated land is also said to have increased in fertility. Wheat and cotton grown on such treated plots gave significantly higher yields than the controls and in the case of wheat, the quality also greatly improved. The improvement related mainly to the total nitrogen and gluten content which were 2.07 and 11.53 per cent. respectively as against 1.65 and 8.04 per cent. in the control. The treated plots showed a higher content of organic matter in the upper zones of their soils than the controls and it is surmised that the better quality of the wheat in the treated plots may be due to this increased organic matter content. The essential feature of the method is the use of green material as such in contradiction with dry material like straw or *bhusa* which are found to be ineffective. The method deserves to be tried in the case of other difficult weeds such as the hariali grass (*Cynodon dactylon*) of the black cotton soils, a weed which greatly reduces cotton yields and involves much cost and labour to eradicate and is seldom permanently removed even then. The touch-me-not, *Mimosa pudica* is another such weed against which cultural, chemical and other methods are in practice out of the question and a suitable adaptation of this new method deserves a trial.—(*Current Science*, Vol. VII, No. 4, pp. 193-94, 1938.)

* * *

Marketing of Derris Root.

Derris root can be put on the market as whole root, chopped root and powdered root.

The simplest way of treating derris root is to dry the whole of it in the sun and then pressing it into bales (about 220 lb. in 12 cu. ft.). This method is still in use in Malaya; with it, sampling, however is very difficult.

Chopping the root, *i.e.* cutting the root when it is still wet into small pieces and then drying them in the sun or in hot air (not above 50°C.), is a much used method in the Netherlands Indies. The dried cuttings are packed in an ordinary plywood chest, as used for rubber and tea, such a chest containing about 1 cwt.

Much attention nowadays is given in the Netherlands Indies to the possibility of grinding the dried root on the plantation. This must be done with special care and the fineness of the powder must be according to the requirement of consumers. As derris powder is very hygroscopic it must be packed in well sealed bags or tins. In the U.S.A. a special duty of 10 per cent. is charged on powdered root, a difference which is not yet made in Holland.—(Bul. No. 133, *Ber. van de Afd. Hand. van de Kon. Ver. Koloniaal Inst.*, by Ir. W. Spoon.)

BANANA STORAGE INVESTIGATIONS 1937-39.

By C. W. Wardlaw, E. R. Leonard and H. R. Barnell.
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I.—Introduction.

Earlier investigations on the storage of bananas carried out at this Station were concerned with temperature requirements, the storage and ripening behaviour of different varieties, the effect of rapid cooling, the factors governing the incidence of chilling and the diagnosis and control of wastage (Wardlaw & McGuire, 1931, 1932, 1933). In recent work, undertaken from 1937 onwards, attention has been directed to fundamental aspects, involving respiration, transpiration and biochemical investigations of standard grades of fruit during storage and ripening under controlled conditions. From these studies it is hoped that information may be obtained bearing on such problems as the improvement of quality, the possibility of gas storage and the improved control of wastage. Whether or not it will eventually be possible to place on distant markets a larger as well as a better banana is a practical issue to which a considerable amount of attention is now being directed.

In the present paper an account is given of (*a*) ripening of Trinidad-grown Gros Michel bunches from different districts at tropical temperatures, (*b*) a critical consideration of "chilling" in the Gros Michel variety, (*c*) the effect of Cercospora leaf disease on the keeping quality of fruit in storage, and (*d*) bulk storage trials with the I.C.2. banana.

II.—Notes on the Ripening of Gros Michel Bunches at Tropical Temperatures.

By way of extending general information on the ripening of Gros Michel fruit, a practice has been made of holding at tropical temperatures representative bunches from each consignment intended for cold storage for observations on their ripening behaviour. A number of points of interest arising from this procedure may be mentioned here. In each instance bunches of the several commercial grades were held in storage rooms at 80°F.-84°F. and 75-80% R.H., fresh air being blown in every 12 hours. Where possible the fruit selected included "¾-full", "heavy ¾-full" and "full" bunches.*

The following observations were made:—

(*i*) During storage at a steady high temperature the difference in time taken to ripen by the several grades may be greatly minimised. The following record was obtained from one consignment:—

"full": all ripe on 9th-10th day from harvesting (first evidence of ripening on 6th day).

"heavy ¾-full": all ripe on 9th-11th day from harvesting.

"¾-full": all ripe on 11th-13th day from harvesting.

The comparatively rapid ripening of the thinner grades was probably partly attributable to the presence of volatile substances liberated from the more mature grades.

(*ii*) By contrast with the moderately good yellow colour shown by fruit which has been allowed to ripen exposed to the diurnal range of tropical temperature and humidity, all bunches held at the approximately steady high temperature and high humidity of the storage room showed typical "green" ripening, *i.e.* the pulp became soft and ripe, but the skin, though softening in the later stages of senescence, showed little or no development of yellow colour, except, in some instances, in the upper (proximal) hands. Such fruit is sometimes described as "boiled" or "boiled ripe". In the heavier grades, splitting of the skin of the large fingers of the upper hands was general; some splitting may also occur in fingers over the whole length of the bunch. Such splitting typically takes place along the ridges, the actual separation being preceded by a brown necrosis of the ridge tissue. In some instances main-stalks became very slack so that standing bunches tended to bend over.

(*iii*) All bunches were retained in storage for 15 days during which time the skins became dark brown to black in colour while the pulp degenerated to a syrupy consistency, but little or no anthracnose spotting was observed. Fungal wastage, including main-stalk rot was slight. In the final stages of senescence, a well defined watery layer in the pulp immediately below the skin, is typical of such fruit.

(*iv*) As a rule, bunches which had been produced on good medium loam soils were well developed in respect of the number of hands per bunch and the size of individual fruits for the respective grades. In some instances, however, the heavier grades ripened slowly, *i.e.* the apparent maturity at harvesting as judged by the eye was proved deceptive by the ripening trials: in point of fact, some bunches considered to be "full" proved to be less mature than those selected as "heavy ¾-full".

(*v*) Bunches at the diurnal range of tropical temperatures tended to ripen more rapidly than those held at a steady high temperature, though the average temperatures were approximately the same.

III.—Chilling in the Gros Michel Banana.

(*a*)—General Considerations.

It had previously been ascertained that chilling in bananas is a cumulative effect of duration of exposure to undesirably low temperatures during storage, that it is associated with the onset of ripening, and that it may manifest itself in a number of more or less well marked symptoms including failure to ripen, development of abnormal

* The trade terms for banana grades have been discussed elsewhere (Wardlaw and McGuire, 1931, 1932).

skin coloration, abnormal ripening, loss of flavour, and greater susceptibility to the inroads of fungal pathogens (Wardlaw and McGuire, 1931).

It is common knowledge that the heavier the grade of fruit at harvesting the more rapid is the onset of ripening, and hence, if the fruit is being held in cold storage, the greater is the danger of chilling. Thus, whereas the comparatively thin cut of fruit (described as "¾-full") at present exported from Caribbean banana plantations to European markets can usually be held at 53°F. for the voyage period of 12-16 days without chilling, the heavier grades of fruit (described as "heavy ¾-full" and "full") shipped to North American markets would inevitably undergo some ripening during a similar period of refrigerated transport and various chilling symptoms would probably be apparent on discharging bunches from the holds and intensified later during ripening.

Chilling therefore ranks as a factor of first importance which must be avoided in any attempt to place a heavier grade of fruit on British markets. And whereas the risk of chilling might be eliminated by using a higher storage temperature, other and equally undesirable factors, *e.g.*, an increased number of "ship ripes" and greater fungal wastage, would be introduced. Accordingly, it has been suggested that a possible solution lies in the application of gas-storage such as has already been successfully realised for apples. Such gas storage would, of course, have to be applied conjointly with refrigeration. If commercially feasible, the advantages of this method of transporting bananas would include: (*i*) the possibility of shipping a bigger and better class of fruit and (*ii*) decreased expenditure on refrigeration.

The investigation of this problem will involve a very considerable programme of biological and technical research. Preliminary work on this subject is now being undertaken. As an essential preliminary step, it was considered that a critical re-examination of chilling in the Gros Michel banana should be undertaken accompanied by biochemical investigations of normal and chilled fruit. The general observations which have been made during the course of such experiments are considered below, the more fundamental scientific results being treated extensively elsewhere. (*See* forthcoming memoir from this Station and papers submitted to the *Annals of Botany*.)

(*b*)—Observations on the Cold Storage and Ripening Behaviour of Fruit of Different Grades.

The behaviour during storage at 53°F. followed by ripening at 68°F. in rooms cooled by the battery system (Wardlaw, Leonard and Watts, 1938) of standard "¾-full" (English grade), "heavy ¾-full" and "full" (American grades) bunches has been made the subject of a number of storage trials, the bunches being held at tropical temperatures for 24-36 hours before storage as occurs in normal commercial practice. Table I gives the principal observations made during a typical cooling schedule.

Table I.

Observations during cooling of bunches.

Flesh temperature of fruit on arrival	...80°-82°F.
Loading commenced (110 bunches)	2.40 p.m. (15.11.1937).
Brine temperature ...	...32°F.
Room temperature ...	...50°F.
Loading completed ...	...4.15 p.m.
Room blown out ...	...4.30-4.45 p.m.
Air temperature at 4.45 p.m.	...79.5°F.
Brine temperature at 5.25 p.m.	...38°F.
Delivery air stabilised at 53°F. (with brine 12°F. lower)	12 noon (16.11.1937).
Flesh temp. at this time	...58°F.
Flesh temp. 4 p.m. 17.11.1937, with delivery air at 53°F. (at this point flesh and return air temp. practically coincided)	...54°F.

During the remainder of the cold storage period the air delivery temperature was maintained at 53°-54°F.

Ripening of heavy grades during cold storage.—The first appearance of ripening colour was noted during the 11th-12th day in storage at 53°F. From the 11th to the 15th day a considerable number of bunches showed colour development with concomitant chilling.

Table II gives the record of ripening at 53°F. for fruit from two localities observed when bunches were being transferred to the ripening rooms on the fifteenth day.

Table II.

Condition of different grades after 15 days stora e at 53°F.

Grade.	Condition.	Toco fruit. No. of bunches.	%	San Juan fruit. No. of bunches.	%
"¾-full"	green	27	90	38	90.5
	colouring	3	10	4	9.5
"Heavy ¾-full"	green	8	44	1	7
	colouring	10	56	13	93
"Full"	green	0	0	0	0
	colouring	3	100	3	100

It will be noted that most of the heavier grade bunches had undergone some ripening during cold storage and chilling symptoms were in evidence.

Ripening at 68°F. after cold storage.—The Toco fruit was divided into two comparable lots and ripening at 68°F. (*a*) with a relative humidity

of approximately 70 per cent. (and air change once every 1.5 mins.), and (*b*) with a relative humidity of approximately 86-90 per cent. (and air change once every 4 mins.).

In the "heavy ¾-full" Toco bunches which had not shown colour development at 53°F. ripening began after 1-2 days at 68°F. and chilling symptoms were observed. Table III gives the ripening record obtained.

The following brief annotation may be added:

(*i*) Standard "¾-full" bunches behaved normally in every respect.

(*ii*) With the cold storage procedure used, corresponding to standard practice, Gros Michel bunches heavier than "¾-full" cannot be held at 53°F. in the green, unripe condition for more than 10-12 days.*

(*iii*) The onset of ripening at 53°F. is denoted by the development of yellow ripening colour, this being modified by the sooty or bronze colours indicative of low temperature injury.

(*iv*) On removing bunches to a ripening room at a temperature of 68°F., the heavier grades show a rapid development of ripening and chilling colour, but during the later stages of ripening, the bronze or sooty chilling colours may be masked by the strong development of the normal yellow pigment.

(*v*) To a varying degree the flavour of the "heavy ¾-full" fruit was abnormal, being noticeably flat in the more severely chilled bunches. The mucilaginous, floury and not fully sweet pulp tended to linger on the palate, presumably in relation to a residual astringency. It was also considered that the normal banana bouquet was less strongly marked, but this requires substantiation; various "wild" or abnormal flavours could also be detected by some tasters. Iodine tests, in conjunction with palatability tests, suggest that the relatively incomplete hydrolysis of starch, and the persistence of other metabolites characteristic of unripe fruit, may be responsible for the condition observed.

(*vi*) The unfavourable dietetic and digestive qualities sometimes attributed to the banana may thus be due (*a*) to the fact that slightly chilled bunches are of more frequent occurrence in consignments than has been previously thought, and (*b*) that in so far as chilling colours may often become masked during ripening, chilled fruit, which partakes to some extent of the nature of unripe fruit, may be unwittingly released on the market along with fruit which has ripened normally. If this can be substantiated, the scope for practical improvements would appear promising.

Table III.

Ripening at 68°F. at low and high humidity.

(A) Ripening at low humidity.

Grade.	6th day.	8th day.	10th day.
"¾-full" ...	70 per cent. ripe: flavour normal; 8 per cent. coloured to ripe; 22 per cent. green to coloured.	93 per cent. eating or almost eating ripe; flavour normal; 7 per cent. green-colouring.	All bunches quite ripe 80 per cent. showing freckling but no finger-dropping.
"Heavy ¾-full"	50 per cent. ripe; 50 per cent. almost ripe. Chilling indicated by appearance and flavour.	100 per cent. ripe; chilling symptoms not extended; no finger-dropping.	
"Full" ...	100 per cent. ripe; chilling indicated by appearance and flavour.	Beginning of brown freckling of skin, *i.e.* onset of final senescence.	
(B) Ripening at high humidity.			
"¾-full"	12 per cent. ripe; flavour normal; 63 per cent. almost ripe. 25 per cent. green-coloured.	100 per cent. ripe; flavour normal; no chilling, 50 per cent. freckled.	All bunches showing extensive freckling and skin darkening.
"Heavy ¾-full"	62 per cent. ripe; chill colours almost masked but flavour subnormal; 38 per cent. almost ripe.	100 per cent. ripe; flavour of chilled fruit, but chilling colours almost masked; general freckling in all bunches.	
"Full" ...	100 per cent. ripe; chill colours almost masked; flavour subnormal.	Fruit freckled and darkened, *i.e.* past eating ripe.	

* As a qualification to this statement which refers to this particular lot of fruit, it should be mentioned that we have on several occasions handled large bunches—the result of rapid growth under favourable conditions—which would have been classified as "heavy ¾-full" but which behaved during storage and ripening like bunches of the lower grade.

(*vii*) In some of the larger, markedly tapering bunches, the several aspects of ripening under different degrees of chilling can be compared on proceeding from the large upper to the small lower hands.

(*viii*) Finger dropping, spotting, main-stalk rot and general fungal wastage were not accentuated by the amount of chilling sustained in this storage trial. The wastage record of this consignment of fruit, particularly with respect of anthracnose (*Gloeosporium musarum*) and *Botryodiplodia theobromae*, two of the more important pathogens, was negligible. Pitting disease (*Piricularia grisea*), was present on the top hands of some bunches in a mild form.

(*ix*) In fruit ripened at a relative humidity of 70 per cent. there was evidence of desiccation on the 8th day. The manifestations of chilling injury were considerably diminished in those bunches which were ripened at the higher relative humidity.

(*x*) Some uneven ripening within bunches, amounting to 14 per cent., was typical of this consignment.

Ripening at 68° F. after cold storage (San Juan fruit).—The San Juan fruit was ripened at 68°F. with a relative humidity of approximately 80 per cent. The general ripening record of this fruit was comparable with that set out above for Toco fruit, all bunches which had ripened during cold storage developing typical sooty and bronze coloration. Some of this consignment was suspected of having come from plants infected with Cercospora leaf disease (*see* next section). But whereas definite symptoms of the "Cercospora effect" could be observed in fruit ripened at tropical temperatures, these were more or less completely suppressed by the cold storage and ripening procedure adopted. The following observations were also made.

(*i*) A bitter, rancid odour was typical of the room in which this fruit was ripened.

(*ii*) The sooty colours associated with low temperature injury were more pronounced than in the Toco fruit.

(*iii*) Main-stalk rot and general wastage were considerably more pronounced than in the Toco fruit, but to what extent this was a locality factor or associated with the presence of Cercospora leaf disease could not be determined.

Ripening of heavy grades after prolonged cold storage (Toco fruit).—Individual "heavy ¾-full" and "full" fingers were kept in storage at 53°F. for 22 days and then transferred to the ripening room at 68°F. These fruits also showed the onset of ripening and chilling colours as from the 11th to 12th day at 53°F. and had developed conspicuous bronze to russet chilling colours by the 22nd day. On removal to the ripening room, the chilling colours became accentuated, and the fruits failed to ripen but became tough and leathery. On sectioning fruits after 6 days at 68°F. regional ripening, with the production of a honey-colour, had taken place along the central placental region, but a considerable starch content, as indicated by the iodine test, was still present in the outer pulp. Some starch was also present in the central placental strand of tissue, but this may also be observed in normally ripened fruit.

(*c*)—Anomalous Behaviour of Certain "¾-full" Fruit.

A striking example of anomalous behaviour in fruit of English grade ("¾-full") was encountered in the course of these storage trials. A lot of 50 bunches selected on size and general appearance as standard "¾-full" was received from a plantation and placed in cold storage approximately 32 hours after cutting. Rapid cooling, as already recorded, was obtained, and after 15 days at 53°F. the room temperature was raised to 68°F.

During the cold storage period ripening and chilling, as indicated in Table IV, became apparent, 70 per cent. of the bunches being affected after 15 days.

Table IV.

Ripening and chilling in "¾-full" fruit at 53° F.

Days at 53°F.	Per cent. Ripening.	Per cent. Showing chilling.
0	0	0
1	2	0
7	11	0
15	68	70

After 1 day at 68°F. 96 per cent. of the bunches showed evidence of ripening and chilling, and on the 4th day 100 per cent. By the 8th day there was a general softening of fingers, sooty coloration, and development of fungi at bruised areas. There was, however, no general onset of freckling or anthracnose—the usual indications of the onset of final senescence—and the consignment as a whole showed delayed ripening at this stage.

It would not appear from the condition of this plantation that the premature ripening of this lot of fruit was primarily due to the effect of Cercospora leaf disease. Nor had the fruit been held for several days at tropical temperatures before being delivered to the Research Station. A tentative explanation is that the bunches had been affected during their growth by severe drought or intermittent periods of drought, and that, in consequence, the bunches were actually much older and more mature than was indicated by their size. The general behaviour in storage was comparable with that of "full" fruit, and actually more marked in respect of premature ripening and chilling. Gros Michel bananas from this area had previously been found to give abnormal ripening (Wardlaw and McGuire, 1933).

(*d*)—Biochemical Investigations of Normal and Chilled Fruit.

Experimental Method.—In order to gain further insight into the problem of chilling, carefully selected lots of fruit, "¾-full" and "heavy ¾-full", obtained from a Toco plantation, were subjected to different storage treatments, the bunches being sampled at suitable intervals for biochemical analyses. A temperature of 53°F. and relative humidity of 85 per cent. were maintained in the storage rooms, the two grades of fruit being treated as follows:—

(*i*) "¾-full" fruit: "normal" treatment: 14 days at 53°F. and ripening at 68°F.

(*ii*) "¾-full" fruit: "chilling" treatment: 20 days at 53°F. and ripening at 68°F.

(*iii*) "Heavy ¾-full" fruit: "normal" treatment: 7 days at 53°F. and ripening at 68°F.

(*iv*) "Heavy ¾-full" fruit: "chilling" treatment: 14 days at 53°F. and ripening at 68°F.

Thirty similar bunches were used for each test, the bunches being placed in storage 34 hours after harvesting (following trade practice) and rapidly cooled to 53°F.

Storage Results.—The results are indicated in Table V.

Although the extent of chilling during cold storage was less severe in these lots of fruit than in the experiments described above (Table III), the data obtained show clearly the effect produced by a prolongation of the normal cold storage period for each grade. The risk of chilling in transporting the heavier grade of fruit to English markets with a voyage period of approximately 14 days is apparent.

Biochemical Data.—The considerable amount of information which has been obtained on the biochemical changes undergone by normal and chilled fruit will be treated in detail elsewhere but the following points of direct practical interest may be mentioned.

Table V.

Storage and ripening of two grades of fruit.

Grade.	Experiment.	Duration of storage.	No. of bunches ripening.	No. showing chill discoloration.	Remarks.
"¾-full"	(i) Normal Storage	Days at 53°F. 14	0	0	—
		Days at 68°F. 2	4	0	Rate of ripening normal.
		4	29	0	Anthracnose spots conspicuous from
		6	30	0	11th day onwards; spots coalescing
		11	30	0	and fingers falling by 13th day.
	(ii) Long Storage	Days at 53°F. 5	1*	0	* Probably bunches from plants with
		8	2*	0	Cercospora leaf disease. (These
		13	2	0	were withdrawn from storage.)
		16	4	3	
		20	6	10	
		Days at 68°F. 2	21	18	Anthracnose spots developing on
		4	30	28	9th day, and infections well
		7	30	29	advanced on 12th day.
		9	30	30	
"Heavy ¾-full"	(iii) Normal Storage	Days at 53°F. 4	0	0	—
		5	0	0	
		7	1	0	
		Days at 68°F. 3	10	0	All yellow ripe on 10th day and
		6	27	0	anthracnose spotting on 17 bunches.
		9	29	0	
		10	30	0	
	(iv) Long Storage	Days at 53°F. 14	1	0	Colouring and chilling not generally
		15	1	0	conspicuous.
		Days at 68°F. 2	10	0	Anthracnose spots on 19 bunches on
		5	30	23	6th day; severe skin darkening on
		6	30	23	10th day.

(*i*) In fruit which has behaved normally and which has not suffered from chilling, only minor changes can be observed in the carbohydrate constituents during the cold storage period. But in fruit whose cold storage has been prolonged beyond the normal commercial period for that grade various ripening changes, *e.g.* increase in sugars, hydrolysis of starch, &c., can be observed before the fruit is transferred to the ripening room.

(*ii*) The rate of starch hydrolysis in the pulp of ripening fruit during subsequent ripening at 68°F. has been related to the grade of fruit and to the storage treatment: the rate of hydrolysis is greater in "heavy $\frac{3}{4}$-full" fruit than in "$\frac{3}{4}$-full" fruit; in "chilled" fruit the rate of hydrolysis is relatively low by comparison with standard grades which have undergone cold storage without chilling.

(*iii*) When "eating quality" is considered in terms of chemical composition, although no clear-cut definition can as yet be given, it has been found that a comparatively wide range of values for starch and sugar concentrations fall within the limits of the "eating ripe" condition as judged by skin colour.

(*iv*) "Chilling" produces a fruit which may be somewhat astringent and of poor "eating quality": in general the starch, acid and glycoside contents tend to be high and the sugar content low. Extreme chilling results in almost complete inability of the fruit to ripen, starch hydrolysis, among other processes, being apparently inhibited.

Other experiments on the relation between grade, duration of exposure to a temperature of 53°F. and chilling, afford confirmation of the results outlined above.

IV.—The Effect of Cercospora Leaf Disease on the Storage Behaviour of Bunches.

(*a*)—The Relationship between Leaf Disease and the Ripening of Bunches.

It is known that severe attacks of the leaf disease of bananas caused by *Cercospora musae* are accompanied by a premature ripening of bunches while still attached to the plant (Wardlaw, 1935, 1937). When the disease is less severe, apparently normal green bunches may be harvested, but during the 30 to 36 hours that elapse before the bunches are charged into the holds, individual fruits or a majority of the fruits in affected bunches may become soft and yellowish. In still less severe infections, affected bunches may escape detection at the wharfside, but may become soft and coloured during the period of refrigerated transport. Bunches which are only slightly affected may behave as approximately normal fruit.

In bulk storage trials, details of which are given below, it has now been conclusively demonstrated that, when bunches, harvested at "$\frac{3}{4}$-full" (English) grade, from a plantation showing what might be described as an intermediate intensity of Cercospora leaf disease, are held at 53°F. for 15 days with subsequent ripening at 68°F., evidence of abnormal storage behaviour can be observed. As in the premature ripening observed in the field, the pulp of affected fruits has a distinct buff-salmon colour, and the flavour is abnormal. These observations are important in view of the status to which Cercospora leaf disease has now attained throughout the Caribbean region.

(*b*)—First Trial with "Cercospora Bunches."

In April, 1938, Gros Michel bunches of English grade were obtained from two plantations, one of which was severely affected and out of commercial production, the other showing a medium intensity of leaf infection but still productive. After a preliminary period of exposure to tropical temperatures the fruit was stored at 53°F. for 15 days with subsequent ripening at 68°F. and 85 per cent. relative humidity. Some bunches were also ripened at 85°F. without previous cold storage.

Behaviour of fruit from severely infected plantation.

(1) *During ripening at* 85°*F.*—Of 6 bunches of "thin $\frac{3}{4}$-full" fruit placed in storage at 85°F. on the day of harvesting, one bunch showed yellowing of some fingers after one day, two bunches finger yellowing after three days, and three bunches were "sprung"* to yellow by the fifth day. Three days later all the bunches were ripe or colouring. These data indicate the very rapid onset of ripening in fruit from a severely affected plantation. All bunches showed buff-coloured pulp and extensive anthracnose spotting rapidly succeeded the "eating ripe" stage.

(2) *During storage at* 53°F. *and ripening at* 68°*F.*—The 25 bunches selected were still quite green when placed in cold storage. By the eleventh day ripening of some of the bunches was readily observable, and after 13 days 30 per cent. were colouring, the pulp of such fruit having a conspicuous buff-colour. On the fifteenth day, when the fruit was transferred to the ripening room, 60 per cent. of the bunches showed premature ripening. The subsequent ripening of the bunches at 68°F. was rapid, only 12 per cent. (thin bunches) remaining green on the fifth day.

As the fruit became yellow, chilling symptoms developed, particularly in the large upper hand. The buff-salmon colour associated with severely affected bunches in the plantation was apparent in all bunches, on the inner surface of the skin, on the exterior of the pulp on removing the skin, and in sections of the pulp. The flavour of such fruit has been described as "banana flavour with a superimposed mustiness". A bitter odour is sometimes noticeable in storage rooms where such fruit is ripening.

The results of this trial, with a "thin" grade of fruit, thus showed:

(*i*) the prevalence of what may be described as the "Cercospora effect" in fruit from a severely diseased plantation;

* *i.e.* when the fruit has gained a definite flexibility.

(*ii*) that affected fruit can easily be detected after cold storage and ripening treatment; and

(*iii*) that part of the effect is to cause premature ripening during cold storage, with concomitant chilling.

Behaviour of fruit from a plantation showing a medium intensity of infection.

(1) *During ripening at 85°F.*—Twenty bunches of "thin ¾-full" grade were received. The four largest bunches ripened normally at 85°F. in the course of 6 to 10 days, showing that even in a generally infected plantation some bunches can develop to standard size without exhibiting the "Cercospora effect".

(2) *During storage at 53°F. and ripening at 68°F.*—Only one bunch showed colour development during the 15 days' storage at 53°F. Table VI gives the ripening record at 68°F.

Table VI.

Ripening at 68°F.

Days at 68°F.	Condition of 16 bunches.				"Cercospora effect."
	Brown.	Yellow.	Yellow-Green	Green.	
0	...	0	1	15	1
6	0	7	5	4	8
13*	10	4	2	...	8

* Rising temperature after 9th day.

After 6 days in the ripening room, 75 per cent. of the bunches ("thin ¾-full" grade) were ripe or yellowing, and 50 per cent., showed buff-coloured pulp and slight chilling externally. This fruit was characterised by poor, flat flavour. The large top hands were most severely affected, but the discoloured pulp could be traced throughout the bunch.

It is inevitable that a large number of bunches could be detected in the ripening room as having come from a plantation where a more or less severe Cercospora infection was present.

(*c*)—Second Trial with "Cercospora" Bunches.

For the purposes of this trial, conducted in November, 1938, an independent, knowledgeable banana agent was asked to submit 30 commercial bunches from each of three areas: (*i*) free from Cercospora leaf disease or as nearly so as possible; (*ii*) showing light to medium infection; and (*iii*) showing medium to severe infection. The consignments, in which bunches from small to large size were present, were held at tropical temperatures for 30 hours, then placed in storage at 53°F., and after 15 days were transferred to the ripening room at 68°F.

Survey of pulp coloration.—A preliminary survey of the bunches, particularly those from the two infected areas, was made on receipt by taking single fingers at random from each bunch and examining them for the characteristic abnormal coloration of the pulp, three or four such samples being selected. With a little practice it became possible to distinguish three categories of pulp coloration:

(*a*) normal, the pulp being predominantly white;

(*b*) very pale buff colour, which would probably escape the untrained observer, to a pale buff colour sufficiently definite as not to escape detection;

(*c*) medium to strongly developed buff colour which could not fail to be noticed.

The records of four samples from the light-to-medium and three samples from the medium-to-severely infected bunches are shown in Tables VII and VIII respectively. Allowance must be made for the personal factor in such observations, based as they are on relatively subtle colour differences. It may be mentioned at this point that two of the bunches from the area considered to be almost free from Cercospora leaf spot were affected.

Table VII.

Pulp coloration in fruit from a light-to-medium infected plantation. (29 *bunches*).

Sample	First	Second	Third	Fourth	Average
No coloration (*a*)	8	6	5	4	6
Slight to medium coloration (*b*)	14	12	12	13	13
Medium to strong coloration (*c*)	7	11	12	12	10

From this it is evident that not more than 4 bunches (14 per cent.) were quite free from some perceptible trace of the "Cercospora effect", and that 12 (41 per cent.) were unmistakeably severely affected. In all, upwards of 50 per cent. of this lot of fruit could have been readily set aside as showing the "Cercospora effect".

Table VIII.

Pulp coloration in fruit from a medium to severely infected plantation. (29 *bunches*).

Sample.	First.	Second.	Third.	Average.
No coloration (*a*)	1	1	1	1
Slight to medium coloration (*b*)	12	17	16	15
Medium to strong coloration (*c*)	16	11	12	13

In each sample, Table VIII, one bunch showed freedom from the "Cercospora effect". If 50 per cent. of category (*b*) be taken as being in the medium coloration category, then 70 per cent. of this fruit could have been set aside as showing unmistakeably the "Cercospora effect".

Tables VII and VIII illustrate the interesting point that the intensity of the "Cercospora effect" is not uniformly distributed throughout the bunch; this is also seen in the irregular ripening within the bunch.

Among the fruit in which buff-coloured pulp was noticeable but not accentuated, *i.e.* slightly affected fruit, bunches of 32.4 kg. (71 lb.) ("¾-full" fruit) and 33.1 kg. (73 lb.) ("heavy ¾-full" fruit) were noted. A *medium* "Cercospora effect" was noted in a "¾-full" bunch weighing 31.8 kg. (70 lb.) Since the size of the bunch is related to the area of effective leaf surface it appears that the "Cercospora effect" may be manifested in bunches from plants where leaf destruction could not have been severe.

By reference to Ridgeway's colour standards, the colour of affected fruits varies from *light buff* to *pale ochraceous salmon*; in some prematurely ripening fruits the colour might be classified as *cream colour*.

Table IX.

Record of ripening of bunches showing different intensities of the "Cercospora effect".

(Results stated as percentages.)

Intensity of leaf disease in plantation.	Ripe or colouring.	Green.	Chilled.	"Cercospora effect."
(*i*) Absent to slight	72	28	7	7
(*ii*) Light to medium	100	0	53	80
(*iii*) Medium to severe	97	3	66	97

Record of ripening at 68°*F.*—During ripening at 68°F. observations were made at intervals over a period of 14 days, note being taken of the rate of ripening, the "Cercospora effect", the incidence of chilling, and of fungal wastage. On the eighth day the record given in Table IX was obtained.

The following notes may be added:

(*i*) All "Cercospora bunches" showed rapid development of ripening colour on transference to 68°F. In categories (*b*) and (*c*) 25 per cent. and 30 per cent. respectively of the bunches showed ripening after one day at 68°F.

(*ii*) The severe anthracnose spotting typical of "Cercospora bunches" held at tropical temperatures was not observed.

(*iii*) The extent of main-stalk rotting was normal.

(*d*)—Third Trial with "Cercospora Bunches"

A third trial was made with standard Trinidad export bunches in February, 1939. These were stored at 53°F. for 15 days and subsequently ripened at 68°F. The results are briefly described in Table X.

Table X.

Record of Ripening.

At conclusion of cold storage period	30 per cent. colouring; 50 per cent. with buff-coloured pulp.
After 4 days at 68°F.	....50 per cent. colouring to ripe.
After 8 days at 68°F.	....84 per cent. eating ripe with varying amounts of slatey-grey chilling discoloration on the skin.
After 10 days at 68°F.	More or less severe anthracnose spotting on some bunches.

(*e*)—General Conclusions.

From the data submitted above it may be taken as definitely established that the storage behaviour of fruit obtained from plantations which have been more or less severely infected by *Cercospora musae* is abnormal in several respects which are of importance to wharfside inspectors, shippers and brokers.

Affected fruit is characterised by pulp of a more or less marked buff colour; it tends to ripen prematurely, to chill during the period of refrigerated transport, and to ripen with undesirable rapidity on removal to a higher temperature. So far nothing is known of the biochemical nature of the abnormalities present in affected fruit at harvesting, but after cold storage it may be expected to share some of the undesirable features of fruit which has been chilled.

In conclusion it may be pointed out that the effect of Cercospora leaf disease on the physiology of the fruit is two-fold: (*i*) ripening abnormalities are introduced; (*ii*) bunches tend to remain of small size; hence fruit may actually be considerably more mature than is indicated by its appearance, and departures from the normal storage behaviour for that grade may be anticipated.

V.—Storage Behaviour of the Hybrid Banana I.C.2.

Since 1922, attempts have been made at the Imperial College of Tropical Agriculture, Trinidad, B.W.I., to obtain by hybridisation commercial types of bananas possessing a high degree of resistance to Panama Disease which could, if necessary, be used as substitutes for the susceptible Gros Michel variety. In 1925, a hybrid (derived from *Musa acuminata* as male parent and Gros Michel as female parent) was obtained. This hybrid to which the label I.C.1 has been given has been found to be highly resistant to Panama Disease; it also yields fair sized fruit of good flavour, its chief commercial disadvantage being that it produces occasional seeds. In standard cold storage and ripening tests this hybrid behaved like the Gros Michel, ripening with good colour, delicate texture and pleasing flavour. A second hybrid, labelled I.C.2, and for all practical purposes seedless, has since been produced. Preliminary storage experiments with these two varieties have already been described (Wardlaw and McGuire, 1933). A fuller account of the behaviour of I.C.2 bananas during cold storage and ripening is given below.

(*a*)—Botanical Notes on I.C.2.

This hybrid was obtained by Cheesman (1931) by crossing the wild seeded type *Musa acuminata* as male parent with the Gros Michel as female parent. It possesses resistance in a more or less high degree to both Panama Disease and Cercospora leaf disease. The plant is of tall stature, shows vigorous growth on any reasonably good soil and throws abundant suckers.

When this variety was first distributed among planters for propagation and field tests in different parts of Trinidad, the production of fruit in respect of bunch size, &c., was somewhat disappointing. That this was due to indifferent cultural treatment and in many instances to neglect has been conclusively demonstrated. It has now been shown that with reasonable attention to pruning, plants established on moderately good soils will produce bunches of 8-, 9- and 10-hands as would the Gros Michel under similar conditions.

Preliminary storage trials (Wardlaw and McGuire, 1933) have shown that this variety possesses some of the desirable characters of the Gros Michel.

(*b*). First Bulk Storage Trial.

(1) *Materials.*—Hitherto only occasional bunches of I.C.2 bananas have been available for storage trials, but in March, 1938, with the co-operation of the Trinidad Department of Agriculture, a preliminary bulk storage trial was carried out with 88 bunches procured from five different localities. As little or no cultivation has been given to this hybrid, many of the bunches received were poorly developed, scarred and otherwise excluded from classification as commercial fruit. A sufficient number of bunches, however, had apparently been produced under conditions permitting of normal development, and 7-, 8- and 9-hand bunches of the several commercial grades were accordingly available for observation.

In order to determine the harvesting maturity for this hybrid, bunches were cut over a wide range of size development, and classified (using Gros Michel standards) as "thin", "¾-full", "heavy ¾-full" and "full".

On arrival at the Research Station, all bunches, and also a finger from the middle hand of each bunch, were weighed. In Table XI bunch and finger weights are given for specimen bunches which were classified as being potentially suitable for shipment.

Despite the general tendency towards a shortness of the fingers and the presence of gaps between the hands in some bunches, the I.C.2 banana, in respect of the weights of bunches and of individual fingers, is more closely comparable with the Gros Michel than might have been thought from inspection alone. The shortness and thickness of the fruits in the hybrid bunch is the obvious outstanding difference. Table XII gives some data on the weights of individual fingers in well developed 9-hand bunches of "¾-full" and "heavy ¾-full" grades.

Table XI.

Bunch and finger weights of I.C.2 bananas.

Locality.	Grade.	Weight of 7-hand bunch.	Weight of finger.	Weight of 8-hand bunch.	Weight of finger	Weight of 9-hand bunch.	Weight of finger.	Weight of 10-hand bunch.	Weight of finger.
		kg.	*gm.*	*kg.*	*gm.*	*kg.*	*gm.*	*kg.*	*gm.*
Maqueripe ...	"¾-full" ...	14.3	130	17.9	130	27.5	156	—	—
	"heavy ¾-full" ...	—	—	—	—	27.8	161	—	—
Non Pareil and Tamana	"¾-full" ...	14.5	129	17.1	130	19.3	135	25.7	130
	"heavy ¾-full" ...	17.8	157	24.4	187	—	—	—	—

FIG. 2.—I.C.2 bunches harvested at "heavy ¾-full" (American) grade.

FIG. 1.—I.C.2 bunches harvested at "¾-full" (English) grade.

Table XII.

Weights of fruits in I.C.2 bunches. (grammes).

Hand.	"¾-full."	"heavy ¾-full."
1st	186	230
2nd	185	196
3rd	161	170
5th	156	161
7th	121	146

These weights are closely comparable with those obtained from equivalent Gros Michel bunches. In Figures I and II, illustrations are submitted of good I.C.2 bunches of "¾-full" and "heavy ¾-full" grades respectively.

(2) *Storage and ripening.*—The bunches were stowed in bulk at 53°F. and 85 per cent. relative humidity for 15 days and thereafter ripened at 68°F. and 85 per cent. relative humidity.

Except in those bunches classified as "full," no evidence of colouring was present at the end of the cold storage period. Table XIII gives ripening data for the several grades.

Notes on the ripening of the several grades.—(*i*) A notable fact was the apparent absence of chilling in the two heavier grades. The rate of ripening for the "heavy ¾-full" bunches was approximately that required by the Trade. The absence of finger dropping, resistance to bruising, the clear yellow skin colour, and good palatability of this and of some of the "¾-full" grade were also noteworthy.

(*ii*) The slow ripening of the "¾-full" (English) grade and low percentage of ripe bunches on the 9th day at 68°F., suggest that the actual maturity of this grade at harvesting was rather less than that of the corresponding grade in the Gros Michel.

(*iii*) The "¾-full" bunches which showed delayed ripening were characterised by (*a*) uneven ripening of the bunch as a whole, (*b*) uneven ripening within the hands, (*c*) poor colour (resembling chilling colour, *i.e.* pale, sooty, but attributed to immaturity), (*d*) poor flavour, (*e*) an excessive odour of amyl acetate, (*f*) excessive rotting of the main-stalk.

(*iv*) Some bunches in the "thin" grade ripened normally. Like the Gros Michel, the I.C.2 will apparently ripen over a wide range of maturity (as judged by bunch size) but slow ripening is not only productive of a less attractive fruit but also makes for excessive stalk rotting. In point of fact the experiment had to be terminated on the 12th day because a majority of main-stalks showed rotting over 50 per cent. of their length.

(3) *Wastage.*—Excessive main-stalk rot, due to *Botryodiplodia theobromae*, *Thielaviopsis paradoxa* and *Gloeosporium musarum* has already been noted. Some stalks were rotted over 50 per cent. of their length, cushions, finger-stalks and fingers being affected. *Gloeosporium musarum*, in the form of large spreading spots, was conspicuous on some bunches. Pitting disease, due to *Piricularia grisea*, was noted on bunches from the several localities. *Botryodiplodia theobromae* and *Fusarium sambucinum* were noted as causing finger

Table XIII.

Ripening of I.C.2 bunches at 68°F. and 85 per cent. R.H.

Days in ripening room.	Total number of bunches.	Grade.	Brown and senescent.	Yellow.	Yellow-green.	Green.	Remarks.
5	9	"Full"	0	8	1	0	No evidence of chilling in any grade; no evidence of finger-dropping; main-stalk rot developing.
	15	"Heavy ¾"	0	11	4	0	
	40	"¾-full"	0	6	27	7	
	24	"Thin"	0	0	11	13	
9	9	"Full"	5	4	—	—	Slight tendency to finger-dropping. No chilling.
	15	"Heavy ¾"	3	12	—	—	No chilling, flavour good.
	40	"¾-full"	0	17	19	4	Uneven ripening.
	24	"Thin"	0	4	14	6	Uneven ripening.
12	9	"Full"	9	—	—	—	All black.
	15	"Heavy ¾"	15	—	—	—	All darkening.
	40	"¾-full"	23	5	11	1	Uneven ripening.
	24	"Thin"	1	9	9	5	Some failure to ripen.

diseases. A characteristic lesion or split, accompanied by fungal rotting, occurred at the junction of the finger stalks and cushions, on the under side—a result of the thickening and pushing apart of fingers.

(4) *General consideration of results.*—On the whole the results of this storage trial were disappointing. But in considering the irregular ripening behaviour of bunches and the excessive amount of main-stalk rot, it should be borne in mind that the season as a whole had been unfavourable to bananas and that many instances of abnormal behaviour had also been observed in Gros Michel bunches kept under observation at the Research Station during the same period. Accordingly it was evident that a second bulk storage trial with I.C.2 should be undertaken with bunches of known age if possible and produced, for preference, under normal wet season conditions.

(*c*)—Second Bulk Storage Trial.

(1) *Materials.*—Fruit for a second bulk storage trial was received from several localities in November, 1938. Of 97 bunches received, 4 were of 10 hands and 13 of 9 hands. Much of the fruit, however, consisted of thin, small, ill-formed, scarred or bruised bunches which could not be classified as export fruit.

Since an exact comparison between the Gros Michel and the I.C.2 throughout the period of development to full size has not yet been undertaken, the grading of the latter though based on Gros Michel standards was to some extent of an arbitrary nature. As *English, i.e.* "¾-full" grade, those bunches were selected in which the angles of the fruit were just being rounded out as in that grade in the Gros Michel. Fruit below this grade was classed as "thin". As *Canadian, i.e.*, "heavy ¾-full" grade, those bunches were selected in which the fingers of the large top (Trade-bottom) hand were just being splayed out by the growth in diameter of the individual fingers. Where fingers throughout the bunch were being splayed out in this fashion, the fruit was classed as "full".

Table XIV gives weights of bunches which would have been described as "quality fruit" by the Trade, *i.e.* well grown bunches for the particular grade under consideration.

It will be noted that bunch weights, as judged by comparison with the Gros Michel, are good. The shortness of fingers, one of the more obvious features of the I.C.2, may vary considerably from bunch to bunch. In the "full" grade, an occasional fruit showed that incipient ripening had taken place on the plant, with concomitant splitting of the skin. Many bunches showed evidence of animal or insect scarring—an indication of the conditions under which this hybrid is at present being grown in Trinidad.

(2) *Storage and ripening.*—The fruit was stored naked in bulk at 53°F. for 15 days, then transferred to two ripening rooms at 68°F. with relative humidity of approximately 75 and 85 per cent.

On transference to the ripening rooms the following observations were made:

(*i*) In the "heavy ¾-full" and "full" bunches some ripening had taken place during cold storage, indicating that the grading was comparable with that used for the Gros Michel. All the "thin" and "¾-full" bunches were still green and firm. Some of the smaller bunches of "thin" grade were of very good appearance, such as might prove suitable for the French market (*i.e.* provided they could be induced to ripen well and free from main-stalk rot).

(*ii*) Although the heavier bunches had yellowing fingers, the chilling symptoms which would have been present in the Gros Michel were not evident.

Table XIV.

Weights of I.C.2 bunches.

Locality.	Grade.	No. of hands.	Range in weight of bunches (kg.)	Av. Weight.	
				kg.	lb.
Non Pareil	"Full" ...	9	27.5-35.5	31.0	68.3
	do. ...	8	30.0	30.0	66.1
	"Heavy ¾-full" ...	10	29.8-36.85	33.0	72.8
	do. ...	9	26.1-31.2	28.7	63.3
	do. ...	8	21.5	21.5	47.4
	"¾-full" ...	9	22.5-25.7	24.1	53.1
	do. ...	8	19.6-25.0	23.0	50.7
Alandale	do. ...	9	26.5-29.3	27.9	61.5
La Louisa	do. ...	9	31.1	31.1	68.6
Kern Oilfields ...	do. ...	9	23.3	23.3	51.4
	do. ...	8	23.3-23.9	23.6	52.0
San Juan	do. ...	8	23.6	23.6	52.0

(*iii*) Main-stalk rot was much in evidence in some of the "heavy ¾-full" bunches, involving the lowermost (small) hands. Six in thirty-five (*i.e.* 17 per cent.) had 2 ins. or more of main-stalk rotting at the thick end.

(*iv*) Profuse pitting disease was present in its early stages.

After 7 days in the ripening rooms the following observations were made:

No. 1 room 68°F. *75 per cent. relative humidity.*—

(*i*) Although the room was blown out once per day and later twice a day, there was a prevailing strong odour of pear drops (amyl acetate).

(*ii*) All the heavier grades, including "¾-full" bunches, were quite ripe. Bunches in the "thin" grade were green or partly ripe. Irregular ripening was a feature of some bunches.

(*iii*) No chilling was observed in English or Canadian grade bunches.

(*iv*) There was in general less finger splitting than in the first trial, though some bunches showed considerable splitting and evidence of desiccation.

(*v*) Blemishes due to bruising became black, being in this respect comparable with those observed in the Gros Michel.

(*vi*) There was no finger dropping, the hands remaining firmly attached to the main stalk and the fingers to the cushions.

(*vii*) Main-stalk rotting had not advanced except in those bunches where it was noted at the end of the cold storage period: this tendency is probably related to external conditions during development.

(*viii*) Pitting disease had developed from the top to the fourth hand in some bunches causing a marked blackening of the cushions and finger stalks, but there was no finger dropping.

(*ix*) Some Botryodiplodia tip rot of fingers was present.

(*x*) Flavour was good, but with a pronounced taste and bouquet of pear drops: in the heavier grades the pear-drop aroma and flavour tended to be somewhat excessive for most palates.

No. 2 Room 68°*F.*, 85 *per cent. relative humidity*—

(*i*) All bunches were ripe, except "thin" grades: colour was good, with some irregular ripening.

(*ii*) Split fingers were not common.

(*iii*) Main-stalk rot had not advanced.

Other observations were in agreement with those for fruit in No. 1 Room.

After 14 days at 68°F., all the "thin" bunches in the two rooms had ripened, but rather slowly and irregularly. The colour and flavour of individual fruits was good.

(*d*). General Conclusions from the Two Bulk Storage Trials.

Several interesting results have accrued from these trials.

(*i*) When the I.C.2 banana is grown under favourable conditions, it is capable of yielding good bunches, as judged by appearance, symmetry and weight of individual fingers, 9-, 8- and 7-hand bunches, suitable for export, being represented among the collection of fruit obtained from different parts of the Island. While the symmetry of the bunch as a whole and the disposition and shape of individual fingers are admittedly not so good as in the Gros Michel—the female parent—nevertheless the hybrid I.C.2 possesses qualities which would make it commercially important in the event of any major failure of the Gros Michel. Its present value as a source of food among the local peasantry should not be overlooked.*

(*ii*) In relation to current storage and ripening procedure for bananas, the optimum harvesting maturity lies between "¾-full" and "heavy ¾-full", using Gros Michel standards of grading. "Thin" grade fruit is difficult to ripen: "heavy ¾-full" fruit, which behaves well during cold storage at 53°F., ripens with an excessive odour of pear drops.

(*iii*) Main-stalk rot, which in some instances has been severe, is considered to be the result of ecological factors and not an indication of genetical lack of resistance. In other respects the fruit is so constituted as to withstand bruising during normal handling.

(*iv*) The Gros Michel transport temperature of 53°F., with rapid cooling to that temperature, is suitable for the cold storage of this hybrid for 15 days.

It is hoped that larger and more standardised supplies of fruit, grown on good soils with proper attention to pruning, &c., will be available for future trials. A brief note by Parham (1938) indicates that the behaviour of this variety in Fiji has so far proved satisfactory.

It is generally agreed that the ideal hybrid banana of the future is likely to be one derived from the Gros Michel as female parent. Whether or not the I.C.2 eventually becomes acceptable as a commercial banana, any data which can be collected on its growth in the field and physiology in storage will contribute materially towards the central object of this work, *i.e.* the maintenance of supplies of fruit of good quality.

VI.—Summary.

1. An account is given of the ripening of Gros Michel bunches of different grades at tropical temperatures.

* This, incidentally, would provide a means of increasing the amount of propagating material in the event of large scale cultivation becoming obligatory.

2. In relation to the project of attempting to ship a heavier grade of fruit to English markets a critical re-examination of the incidence of chilling during refrigerated storage has been undertaken. The development of chilling injury is closely associated with the onset of ripening during cold storage. It has been demonstrated that grades of fruit heavier than "$\frac{3}{4}$-full" will almost inevitably show some chilling if maintained at 53°F. for more than 11 to 12 days.

3. As well as the ordinary manifestations of chilling, which are described, it has been shown in biochemical investigations that in fruit whose cold storage has been prolonged beyond the normal commercial period for that grade, various ripening changes can be observed in the carbohydrate constituents, whereas in fruit which has not been subjected to such chilling only minor changes can be observed.

4. As a result of chilling, fruit may be somewhat astringent and of poor eating quality, the starch content tending to remain high and the sugar content low. Extreme chilling results in almost complete inability of the fruit to ripen, the starch hydrolysis mechanism among others being apparently inhibited.

5. An account is given of storage trials with fruit from plantations affected by Cercospora leaf disease. It has been definitely established that fruit from such plantations is abnormal in several respects which are of importance to wharfside inspectors, shippers and brokers.

6. Affected fruit is characterised by pulp of a more or less well marked buff colour; it tends to ripen prematurely, to chill during the period of refrigerated transport and to ripen with undesirable rapidity on removal to a higher temperature.

7. An account is given of two bulk storage trials with the hybrid I.C.2 banana. When grown under favourable conditions this hybrid is capable of yielding good bunches. While the symmetry of the bunch as a whole and the disposition and shape of the individual fingers are not so good as in the Gros Michel, nevertheless this fruit possesses qualities which would make it commercially important in the event of any major failure of the Gros Michel.

8. In relation to current practice, the optimum harvesting maturity for the transport of the I.C.2 at 53°F. lies between the "$\frac{3}{4}$-full" and "heavy $\frac{3}{4}$-full" grades of the Gros Michel. "Thin" fruit is difficult to ripen expeditiously and "heavy" fruit tends to have an excessive aroma of pear drops.

9. After a cold storage period of 15 days at 53°F., standard bunches can be ripened at 68°F. to a product of good colour, flavour and texture. In no instance has severe finger dropping so far been observed.

In conclusion the writers desire to express their thanks to the Director and Officers of the Trinidad Department of Agriculture, to Messrs. Kern Oilfields Ltd. and to members of the planting community for their very helpful co-operation in providing supplies of fruit.

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MOSAIC DISEASE OF CASSAVA.

A virus disease which causes a mosaic-like mottling of the leaves of cassava (*Manihot utilissima*) has been known in East Africa since 1894, and there has been an increasing recognition of the serious nature of the disease. H. H. Storey and R. F. W. Nichols, of the East African Agricultural Research Station, Amani, have recently made detailed studies of the malady and its transmission (*Ann. App. Biol.*, 24, No. 4, 790-806; Nov. 1938). Symptoms exhibit wide variation, owing to varietal reactions of the host, and also to differences in strains of the virus. Two groups of strains have been recorded, one giving mild, and the other severe, symptoms. Cassava mosaic has not been transmitted to a healthy plant by mechanical means; but it can pass across a graft union, and has an insect vector, a species of *Bemisia*. The latter can only inoculate a plant through an immature leaf, a fact which should be useful in experiments upon movement of the virus. It has been found already that the virus does not pass out of the inoculated leaf until after eight days. It then moves quickly to the base of the stem, and slowly into the side branches. The presence of a mild strain of the virus does not confer any resistance against the more severe kind.—(*Nature*, Vol. CXLIII, No. 3623, p. 607, 1939.)

SOME REMARKS ON CHILE SALTPETRE IN RELATION TO THE BORON QUESTION.*

In practice it is usual to distinguish between commercial fertilisers according to their chief constituents. Thus nitrogenous, phosphatic and potassic fertilisers are spoken of as if they contained only these constituents, and although the importance of other components of the molecule is recognised, insufficient attention is paid to them. In this connection, the use of such symbols as N, P_2O_5, CaO, &c., instead of the more truly representative ionic symbols NO_3', PO_4''', Ca'', &c. is to be deplored. Consideration of the ionic symbols alone gives a true insight into inorganic equilibrium conditions in the soil and without an understanding of this very sensitive system (where equilibrium is possible only within definite concentration limits) it is impossible to define correct manuring conditions.

In the valuation of fertiliser effects, neither the composition of the absorption complexes in the soil nor the accompanying cations of the fertiliser salts can be disregarded. Indeed, the whole question of ionic equilibrium is one of great complication, not only from a physiological stand-point, but also because variations in the concentration of hydrogen ions and also of all other ions, strongly influence the results of plant nourishment as expressed in harvest yields. Thus, it has been proved beyond question that it is incorrect to estimate a nitrogen fertiliser by the nitrogen content alone, and numerous investigators have shown that the sodium-ion plays a significant rôle, especially in the manuring of carrots. The excessive use of artificial fertilisers such as ammonium sulphate, lacking in certain " trace-elements " found in natural fertilisers, causes the equilibrium in the soil to be disturbed, with the subsequent incidence of certain plant diseases. The development of dry-rot in carrot has been traced to boron deficiency, and the extent of this disease is undoubtedly connected with the intensive use of synthetic nitrogen fertilisers.

Hudig and Lehr confined their attention to the effect of the trace element, boron, on certain plants, using both water and sand cultures. They later extended their investigations to include a comparison of synthetic nitrate fertilisers with natural Chile saltpetre. Boron absorption by maize, mustard and tomatoes in water cultures was first investigated. One water culture was boron-free, while the others contained varying amounts of boron as boric acid. With maize, symptoms of boron deficiency were apparent only after three weeks' growth, whereas with mustard and tomatoes, growth was retarded immediately in boron-free solutions. Maize is therefore considerably less sensitive to boron deficiency than either mustard or tomatoes.

In a soil deficient in both boron and calcium, it was found that mustard was unable to thrive and died after a few weeks, The same effect obtained in a soil that contained boron but no calcium; when, however, further boron was added, the plant developed slowly but did not die. An excess of calcium in the soil was found to be detrimental, in that the plant developed an unsatisfactory appearance. This effect gradually disappeared, and normal growth followed. In a soil deficient in boron, mustard at first grew normally but later showed marked symptoms of boron deficiency.

Hudig and Lehr concluded their investigations by comparing the effect of Chile saltpetre as a boron-containing nitrogen manure with that of the synthetic Arcadian saltpetre and calcium nitrate. Chile saltpetre was found to contain 0.031 per cent. of boron and the two synthetic products practically none. In its effect, Chile saltpetre was superior to either of the synthetic products, but the addition of boron to Arcadian saltpetre made it comparable with the natural product.

H. F. B.

* Abstracted from an article by J. Hudig and J. J. Lehr. *Bodenkunde v. Pflanzenernahrung*, 9/10, (54/55) pp. 552-579, 1938.

REVIEW.

INTERNATIONAL BIBLIOGRAPHY OF AGRICULTURAL ECONOMICS.

Vol. I, No. 1, Oct., 1938. International Institute of Agriculture, Villa Umberto I, Rome. Annual Subscription 6*s*. 6*d*. post free.

The International Institute of Agriculture in Rome has commenced issuing a new quarterly publication consisting of a comprehensive bibliography of current literature on agricultural economics and kindred subjects throughout the world. The bibliography is to be published in October, January, April and June, commencing October, 1938. The work is essentially an extension of the previous publication by the Institute in the German Journal *Berichte über Landwirtschaft*.

The bibliography covers many aspects of agricultural economics. Among the 14 classifications of publications are the following subjects: Agricultural History and Geography; Education and Research; Social and Economic Aspects of Agriculture; Horticulture; and Forest Economics. Within each classification, publications are grouped according to their country of origin. Each publication is concisely indexed, and a clear list of abbreviations used is given at the beginning. In Volume I, 2228 references are given.

There is no doubt that this bibliography will be of great value to librarians and research workers by presenting in concise form references to the current world literature on subjects pertaining to agricultural economics.

A. L. J.

COMPARATIVE INVESTIGATIONS ON THE COMPOSITION OF THE FAT OF THE GERMS SHELLS AND COTYLEDONS OF CACAO BEANS.*

WHEREAS cacao butter is one of the fats that has been most thoroughly investigated, little is known of the composition of the fats of the shell and germ of the cacao bean. Moreover, statements made by various workers in this field have often been contradictory. Accordingly, a study of the shell and germ fats was undertaken by Bauer and Seber. These workers did not determine the actual constitution of the fats in question, but, by the application of standard methods, they were able to compare the composition of germ oils obtained from cacao beans of different known origins. Application of the same technique afforded a means for comparing the composition of various shell fats obtained from different known varieties of cacao, and also of determining the extent to which germ oil and shell fat differ in composition. Bauer and Seber then extended their investigations to cacao butter, and recorded the fluctuations and differences in the composition of germ oil and shell fat in comparison with various samples of cacao butter of known origin.

The conflicting results obtained by various previous investigators of germ oil and shell fat from cacao were due, according to Bauer and Seber, to the difficulty of obtaining cacao shells or germs free from adhering cotyledon particles, and special care was taken by these authors to ensure that only the pure germs and shells were extracted.

Cacao-Germ Oil.

Whilst the fat content of technically-obtained germs may amount to as high as 15 per cent. Bauer and Seber found the average content of a number of pure germ samples which they investigated to be about 3.7 per cent. The solid fatty acids which they isolated from the various fats obtained from different germ samples were identified as palmitic and stearic acids, and the liquid fatty acids as oleic and linoleic acids. No linolenic acid was identified. Germ-oils from different sources were found to be subject to large fluctuations in their composition, especially in their palmitic, stearic, oleic and linoleic acid contents.

Cacao Shell Fat.

The fat extracted from the seed shells is not only a product of the shell, but contains a small amount of fat formed on the shell during fermentation. Bauer and Seber extracted the fat from four different samples of unroasted cacao beans, and sixteen different samples of roasted cacao beans. They found little difference in either the content or composition of the fats from the shells of roasted and unroasted cacao beans and concluded, in contrast with the statements of previous workers, that during the roasting process there is no influx of fat from the bean into the shell. The fat content of the shell was found to be on an average, about 2 per cent.

Fluctuations in the composition of the various shell fats were not so marked as in the case of germ-oil. The amount of unsaponifiable matter was relatively high, the oleic acid content higher than that of germ-oil, and the linoleic acid content less. The ratio of palmitic acid to stearic acid was found to be subject to no great fluctuations in spite of the different origins of the fat (cf. germ-oil). Molecular weight determinations indicated that more stearic acid is present in the fatty acids of shell fat than in those of germ oil.

Cacao Butter.

The authors concluded their investigations with an examination of different varieties of cacao butter, with a view to determining the contents of unsaponifiable matter, oleic acid, linoleic acid and saturated fatty acids. The amount of unsaponifiable matter found in sixteen different samples was extremely small (0.24 to 0.36 per cent.). The average content of oleic acid was 34.7 per cent., of linoleic acid 3.3 per cent. and of saturated fatty acids 62.0 per cent.

Their results may be summarised briefly as follows :—

Germ-oil and shell fat differ in their composition from cacao butter with regard to their high content of free fatty acids, and the presence of oxy-acids, unsaponifiable and insoluble in ether. In addition, their content of unsaturated fatty acids is really higher; germ-oils contain on an average ten times more linoleic acid, but less oleic acid than cacao butter. Shell fats contain the same quantity of oleic acid as cacao butter, but three times more linoleic acid, so that their higher content of unsaturated fatty acids is practically due only to the linoleic acid.

H. F. B.

* Abstracted from articles appearing in *Office Int. du Cacao et du Chocolat*, Vol. IX, No. 3, p. 115, 1939 and *Fette und Seifen*, 45, 293, 1938, by K. H. Bauer and L. Seber.

CAOUTCHOUCINE DENATURANT.

An agent which is coming into favour on sugar estates in different countries for the denaturing of power-alcohol is that known as Caoutchoucine. Added in the amount of ½ per cent. only, it imparts a taste and smell sufficiently disagreeable to prevent the alcohol from being drunk, and it is not easily eliminated by filtration, distillation or other means. It is made by the dry distillation of vulcanized rubber, and may consist of the fraction passing over between about 125 and 300°C. It is now being made in the United Kingdom.—(*Int. Sugar Jr.*, Vol. XLI, No. 483, p.120, 1939.)

INTERNATIONAL CONGRESS OF TROPICAL AND SUB-TROPICAL AGRICULTURE.

THE eighth International Congress of Tropical and Sub-Tropical Agriculture was held at Tripoli during 13th to 17th March, under the presidency of Professor Le Plae, honorary general director of agriculture to the Colonies' Ministry, Belgium. Delegates from Italy, France, Belgium, Holland, Poland, Germany, Bulgaria and other countries attended the Congress, and Great Britain was represented by Sir John Russell as chief Government delegate, and Sir Arthur Hill.

The Congress was opened by H. E. Marshall Balbo, Governor-General of Libya, who also presided at the concluding meeting. At the opening meeting, papers were presented by Professor Armando Maugini on "European Colonization and Native Agriculture in Tropical and Sub-Tropical Countries", by Count Edmond de Warren on "Agricultural Production of the Warm Countries" and by Professor Le Plae on the "Professional Preparation of Native Agriculturists through Compulsory Instruction". The Congress then broke up into five sections. The first dealt with the possibilities of agriculture in tropical and sub-tropical countries, Sir John Russell being one of the presidents of this section. In the second section papers were read on agricultural problems relating to ecology, meteorology, erosion, irrigation and dry culture; while the third section dealt with various economic problems such as credit, labour co-operation and marketing.

The fourth section was in two parts, one devoted to vegetable products, of which Sir Arthur Hill was one of the presidents. Numerous papers dealing with cotton, sugar-cane, rubber, olives and vines in North Africa, citrus, &c., were presented, and also papers dealing with forestry. In the other subsection, papers relating to animal products were read.

The fifth section was devoted to insect and fungus pests of cultivated crops.

Visits were paid to the Agricultural and Zootechnical Experiment Station near Tripoli where fine new laboratories have just been completed; the grounds contain a very representative collection of citrus species and varieties, and of vines, almonds and other trees of economic value. The citrus, including grapefruit, were bearing large crops.

Of particular interest were the visits to the new villages of Crispi, Michele Bianchi and Oliveti, which have been recently built. Crispi, only some four months old, is situated in a seemingly desert plain and consists of some 333 farms with a civic centre where the church, town hall with cinema, hospital, school and co-operative store are arranged around a central square. The farms allotted to each colonist are 37 to 120 acres in extent according to the locality, part being irrigated for the growing of wheat, lucerne, cotton, &c., the rest being dry-farmed with olive and almond trees and vines.

Crispi with its new white houses in this sandy spot was not a prepossessing sight, but a visit to Bianchi and Oliveti, nearly three years old, was a revelation of the possibilities of irrigation and good cultivation, since at the start they were founded on sites as sandy and barren as Crispi.

At these two villages, the olive and almond trees were flourishing and beginning to bear, and the irrigated crops were in very good condition—a great tribute to the good work of the Italian colonists from the Venetian plain and to the foresight of the organizers of these remarkable developments. No doubt in Roman times much of this North African 'desert' country was fertile, else such magnificent cities as Leptis Magna and Sabratha would not have been founded.

The new colonist is provided with his house, sheds and farm on trust, together with the equipment and livestock. After a short time on a fixed salary, he is placed on a crop-sharing basis for about five years and in the sixth year he becomes full owner of the farm and assumes direct management. At the end of nine years, when he has paid one-third of his debt, the colonist becomes full owner of his farm. The whole debt is expected to be paid off before the end of the thirty-fifth year.

This eighth Congress was admirably organized by Dr. Gioacchino Dallari, colonial adviser of the Fascist Confederation of Land Workers, and his staff. The majority of the delegates were conveyed from Genoa, Naples or Messina in the s.s. *Roma*, a fine cruiser of 30,000 tons which served as their headquarters during the Congress.

It was suggested that the Congress in 1941 might be held in England.—(*Nature*, Vol. CXXXIV, No. 3625, p. 690, 1939.)

PROTEINS OF BLACK BEAN.

The following summary is taken from a paper by Messrs. Breese Jones, Gersdorff and Phillips, of the Bureau of Chemistry, Washington, U.S.A., which was published in the *Journal of Biochemistry*, Vol. CXXII, No. 3, pp. 745-755.

The chief proteins of the black turtle soup bean (a variety of *Phaseolus vulgaris*) consist of an α- and β-globulin. These globulins have been isolated and a study made of their nitrogen distribution and amino acid content. They are strikingly similar in their chemical and physical properties to the corresponding proteins of other beans of the *Phaseolus* genus. It is reported that the Mayas subsist almost entirely on maize and this bean, and are a sturdy, healthy race. A comparison of the amino acid composition of the black bean proteins with those of maize indicates a supplemental relationship. The relatively large amount of lysine, tryptophane, histidine, and cystine in the bean proteins is in marked contrast to that of maize.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Report on Power Alcohol in Australia.*—*By L. J. Rogers.*

In this Report of the Commonwealth Fuel Advisor, it is pointed out at the outset that under local conditions in Queensland the manufacture of alcohol for use as a substitute for petrol is uneconomical. It can be justified only by considerations of a national and social character, intended for use as an addition to petrol, say in the proportion of 15 per cent.

At the present time the only firm preparing alcohol in the Commonwealth for this purpose is the Australian National Power Alcohol Co., whose distillery, having a capacity of 1¼ million gallons per annum, is at Sarina. Its price for the power alcohol is 1*s.* 9*d.* per gallon, delivered into distributors' storage tanks. The oil companies are compelled to purchase 1½ gallons of this dehydrated alcohol per 100 gallons of petrol imported for consumption in Queensland.

It is blended in the proportion of 15 : 85 by volume, and sold at a price ½*d.* per gallon less than the standard grades of petrol. To recoup themselves for the higher cost of alcohol, and the lower price of the blend, the oil companies have raised the price of petrol by ½*d.* per gallon. However they do not try to extend their sales of alcohol, and it is not even advertised to draw attention to such virtues as it possesses.

Even if the molasses from which the alcohol is produced costs nothing, and even if the excise duties were completely remitted, the distiller would not be able to produce and deliver power alcohol at a price competitive with the landed cost of imported petrol, which is about 1*s.* 1*d.*, or 1*s.* 1½*d.* per gallon.

For the price of the molasses one can assume 18*s.* per ton delivered distillery (or 3.78*d.* per gallon of available alcohol). The total production of molasses in Queensland is about 16½ million gallons per annum; but of this amount only about 4½ million gallons are sold to distilleries, and of this only 1¾ million gallons go to the power alcohol distillery.

For an output of say 2½ million gallons, the cost of producing power alcohol including storage expenses, depreciation of plant, and a reasonable margin of profit to the distiller, may be estimated at 9*d.* per gallon. Under prevailing conditions the total cost of power alcohol would be: Molasses at 18*s.* per gallon (yielding 57 gallons of alcohol), 3.78*d*; cost of conversion, 9*d.*; freight on the alcohol to the oil companies, 3*d.*; a total of 15.78*d.*, say 1*s.* 4*d.* per gallon.

It has been proposed as an alternative to exporting the quota of 400,000 tons of raw sugar to the United Kingdom that B-syrup should be converted into power alcohol. Assuming that all the motor spirit consumed in Queensland were to contain 15 per cent. of alcohol, the demand on the distilleries would be about 6 million gallons per annum. The total annual consumption of B-syrups for this purpose would be 83,000 tons containing 18,000 tons of recoverable sugar, which would reduce the exported quota by 5 or 6 per cent.

Lastly, there is the scheme propounded by P. J. Phelan that the tops should not be removed from the cane in the field, but should be crushed with the stalk (this to reduce labour in harvesting); that the surplus bagasse thus resulting should be used as fuel for the power alcohol distillery; and that the weak juices recovered in the final stages of crushing be mixed with molasses or B-syrup and sent to the distillery.—(*Int. Sugar Jr.*, Vol. XLI, No. 483, p. 120, 1939.)

* * *

"Neo-Sucre".

This is a sugar prepared by a process invented by Arnold Reymond from whole cane juice, that is, directly without clarification, in such a manner that it is claimed that the vitamins originally present are in no way affected, and its nutrient and calorific values are retained intact.* Cane juice is evaporated almost to its crystallizing point, after which the water remaining is expelled in an atomizing evaporator, and a sugar obtained in the form of very fine crystals of a pale tan colour. It is compressed into blocks, dried and packed. According to Dr. Henri David, athletes were able to assimilate 300 grms. of "Neo-Sucre" each per day without any ill-effects, whereas other subjects fed with the same amount of refined sugar are said to have developed glycosuria.—(*Int. Sugar Jr.*, Vol. XLI, No. 483, p. 124, 1939.)

* *Food Manufacture*, 1939, 14, p. 23.

* * *

Electrometric Method for the Determination of Reducing Sugars.—*By R. C. von Stieglitz and L. C. Home.*

These are some further notes on this method of determining the end-point electrometrically in the titration of Fehling's solution, which has already been described*. The Lane and Eynon technique is followed up to boiling, after which the procedure is: "Boil for exactly two minutes, and then complete the titration within three minutes by making the final addition dropwise. The end-point of the titration is indicated by a reversal in the direction of deflection of the galvanometre needle; one drop of an 0.2 per cent. solution will accomplish this readily . . . Duplicate titrations are usually excellent, and rarely differ by more than 0.05 ml."—(*Int. Sugar Jr.*, Vol. XLI, No. 482, pp. 68-69, 1939.)

* *I.S.J.*, 1929, p. 223; 1936, p. 268.

* *See* also *I.S.J.*, 1938, p. 252.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Thorough Cultivation of Soil.

In most countries, and especially in Great Britain, farmers have a traditional belief in the necessity and virtue of thorough cultivation. Although it is self-evident that some cultivation is needed to secure a satisfactory tilth, it is not certain that additional and deeper workings of the soil are as valuable as has been generally thought. At the present day when cultivation is one of the heaviest expenses on the farm, the question clearly needs reconsideration, and Dr. B. A. Keen has recently given some interesting results of investigations on the subject (*J. Min. Agric.* 45, 645; 1938). Experiments carried out over a number of years on heavy land showed that deep ploughing or subsoiling was of little or no benefit to a sugar beet crop, while extra ploughings, though they produced some small increase in the yield of potatoes and sugar beet, were also uneconomic operations. Similarly, intensive inter-row cultivation of root crops, hitherto regarded as desirable, proved a waste of labour on both heavy and light land. The practice of rolling and harrowing cereals, on the other hand, was supported by experimental evidence. Rotary cultivation received special attention, comparison being made between plots prepared by the plough, the grubber and the rototiller. Germination tended to be quicker on the loose seed bed from the rototiller, but subsequent growth and yield were very similar on all three sets of plots. If time presses, therefore, the quicker and cheaper process of grubbing can safely be substituted for ploughing, but the practice should not be continued for several years in succession, as weeds are liable to increase rapidly. The conclusion that, beyond a certain minimum, cultivation has little influence on crop yield has also been reached from experiments carried out on different soils and under different climatic conditions, but still further work is needed to determine if the results are of general application, or are typical of certain types of soil and climate only.—(*Nature*, Vol. 143, No. 3610, pp. 31-32, 1939.)

* * *

Soil Erosion in Jamaica.

Soil erosion in Jamaica forms the subject of a bulletin (No. 17) issued by its Department of Science and Agriculture. The greater part of the cultivated land is situated on steep hillsides, gradients of one in one being frequent, so that sheet erosion is the major problem. These slopes were originally covered by dense forest and undergrowth, the clearing of which has resulted in rapid loss of surface soil. The rate of loss depends largely on the crop grown. Bananas and coffee, for example, are comparatively widely spaced and are maintained under clean cultivation so that soil exposure is very serious, though the necessity for drains in the case of bananas somewhat alleviates the situation. Sugar-cane, on the other hand, is an excellent soil conserver as it has an elaborate root system, and the trash deposited after reaping forms a protective cover. Of the less important crops, the cultivation of yams, sweet potatoes, corn or ginger encourages erosion, but citrus causes little loss as the trees are usually left in the grass cover. Erosion is also promoted by the otherwise valuable system of forking the soil at the end of the dry season to facilitate the penetration of the first rains, and by the improper placing of drains. Other factors which contribute to the problem are the practice of short-period tenancy, which gives the proprietor little interest in conserving the fertility of his land, and the system of renting land for the production of one type of crop only. Some fundamental changes in the current agricultural practices will be needed if further loss of valuable soil is to be prevented.—(*Nature*, Vol. CXLIII, No. 3617, p. 327, 1939.)

* * *

The Ecology of White Leaf Louse of Sugar Cane. —*By M. Yamasaki and H. Arikado.*

Tests of the cell-sap concentrations in the leaves of twenty varieties of sugar-cane, half of them resistant and half of them susceptible to the attack of the white leaf louse, disclosed the fact that all of the cell-sap concentrations in the susceptible canes were appreciably higher than in the resistant canes. Further tests of infested and non-infested leaves gave similar differences. The minimum critical concentration at which cane leaves appeared subject to attack was about 4.5 (Ref. Brix). In addition to varietal differences in cell-sap concentrations, it was observed that the addition of water by rain or irrigation reduced the cell-sap concentration. The results suggest possible control by choice of varieties and irrigation where indicated, cell-sap concentrations being taken as indices.—(*Facts about Sugar*, Vol. XXXIV, No. 1, p. 44, 1939.)

* * *

Determination of Nitrate in Soils.—*By H. Sallinger and Y. Hwang.*

For the determination of ammonia in filtered soil solutions strongly discoloured by humic substances not removable by precipitation with ferric hydroxide, &c., the authors convert the nitrates into ammonia, which is distilled. Twenty ml. of the solution are diluted with 120 ml. of water in a conical 300-ml. flask. One g. of Devarda's alloy and 0.5 g. of magnesia are added, and 20 to 40 ml. are distilled into a small flask containing a few ml. of water. The distillate or an aliquot part is Nesslerised. Another portion of solution is distilled as before but without the alloy, and the ammonia thus found is subtracted from the first result. A blank determination must be made with each assay. The process is sensitive to 0.01 mg. of nitrogen, and quantities of 0.02 to 0.5 mg. can be accurately determined.—(*The Analyst*, Vol. 64, No. 756, p. 222, 1939.)

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.) :—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
30th March	6	6	10	3
5th April	6	6¾	10	3¾
13th April	6	9	10	6¾
20th April	7	3	11	0
27th April	7	10½	11	7½
4th May	7	3	12	0
11th May	7	3	12	1½
(12th May, 1938)	5	1½		9¾

The gradual hardening in prices which has been in evidence for some time developed into a sharp advance during the period under review. This has been due to an active demand for early shipment Raws and with sellers generally reluctant to meet the market, successive advances in prices have been quickly established. The reason for this accentuated firmness is the increasing evidence of the tight statistical position facing the market. This has been aggravated by the additional demands being made on Raw supplies by Continental refiners, not only for domestic requirements but also to meet the increasing enquiry for refined sugar in export markets occasioned by the withdrawal of sellers of Continental beet whites.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	Pence per lb.
29th March	8
5th April	7 15/16
12th April	7 15/16
19th April	7 15/16
26th April	7 15/16
3rd May	7 15/16
10th May	8
(11th May, 1938)	5 7/8

The market has been inactive but prices have kept steady. As has been the case for so long the dominating factor has been the European political situation and the reactions of the stock markets to the various changes. The American consumption in March at 50,165 tons proved to be higher than had been expected and represents the highest figure of consumption in any month since June, 1937.

* * *

LIME PRODUCTS.—*Lime Oil.*—The market for both handpressed and distilled is quiet with a nominal value of handpressed 25*s.* per lb. and distilled unchanged at 11*s.* *Lime Juice.*—There is still no demand for concentrated and prices are unchanged for raw.—(*West India Committee Circular*, 20th April, 1939.)

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian Giza 7.*	*F.G.F. Sakel.*
31st March ...	4.95	6.67	6.67
6th April	4.92	6.53	6.53
14th April	4.93	6.60	6.60
21st April	4.99	6.60	6.60
28th April	4.96	—	—
5th May	5.28	—	—
12th May	5.33	—	—
(13th May, 1938)	4.77	6.97	7.69

There has been rather a better feeling prevailing on the market. Raw cotton prices have recovered despite a good deal of uncertainty regarding the future policy of the U.S.A. Government which is still experiencing much difficulty in finding a solution to the excessive supply problem. Business in West Indian Sea Island has been moderate at firm prices ranging from 18*d.* to 20*d.* per lb.

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COCOA.—During the past month the tense European political situation which has been the motivating factor governing the price movements of most markets also influenced cocoa. Reports from Accra state that the Department of Agriculture estimates the 1938/39 main crop at 270,000 tons, of which 1,000 tons are still to be marketed. This unsold cocoa is in strong hands and such interests have shown no desire to dispose of their holdings at present low prices. The preliminary estimate of the 1939 mid-crop is 18,000 tons and is quoted at 22*s.* c.i.f. Locally $7.50 per fanega is paid for Plantation marks.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

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SPICES.—*Pimento.*—The market is quiet with sellers at 72*s.* c.i.f. Havre for orders for April shipment. Spot London is quiet at 7 7/8*d.* per lb. *ex* store. *Ginger.*—Small sales are being made on the spot in London for prices around 30*s.* per cwt. for Old Crop No. 3. Business on c.i.f. terms in new crop No. 3 f.a.q. has been around 25*s.* *Nutmegs.*—3*d.* per lb. for wormy and broken, 3¾*d.* to 4*d.* for unassorted slightly defective at 4½*d.* to 4¾*d.* for sound unassorted. Sound 80's remain at 6*d.* *ex* store. *Mace*—continues quiet at 1*s.* 6*d.* for mixed red to pale. Fine pale is quoted at 1*s.* 8*d.*—(*West India Committee Circular*, 20th April, 1939.)

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COPRA.—Very steady, West Indian f.m.s. being valued at £10 17*s.* 6*d.* c.i.f. London-Liverpool option. — (*West India Committee Circular*, 20th April, 1939.)